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Supreme Court of the United States

October Term, 1930.

No. 630.

DeForest Radio Company,

Petitioner,

v.

General Electric Company,

Respondent.

REPLY BRIEF ON BEHALF OF PETITIONER.

Thomas G. Haight,
Samuel E. Darby, Jr.,
Counsel for Petitioner.

IN THE

Supreme Court of the United States

October Term, 1930.

No. 630.

DE FOREST RADIO COMPANY,

Petitioner,

v.

GENERAL ELECTRIC COMPANY,

Respondent.

ON PETITION FOR WRIT OF CERTIORARI TO THE CIRCUIT COURT OF APPEALS FOR THE THIRD CIRCUIT.

REPLY BRIEF ON BEHALF OF PETITIONER.

There are some statements made in Respondent's brief to which we think we should make brief reply in order that the Court may not be under any misapprehension as to certain of the facts which we assume will be taken into consideration in determining whether or not the writ of certiorari should be granted.

1. Perhaps we should point out, although it must be evident from our main brief, that this is not an "ordinary patent case with the usual issues", such as this Court in several cases has said that it would not bring before it for review. It is a very unusual patent case, in that the Circuit Court of Appeals has entertained two different views as to

the validity of a patent covering an article of very great public, economic and industrial importance. The patent now stands established as valid, by the last decision of the Circuit Court of Appeals, on the changed decision of one judge, who gives no reason for his change except in so far as he concurs in the opinion of another judge. As pointed out in our main brief, this opinion is silent on questions of fact which were dispositive of the case as found by the Trial Judge, and accepted by the first decision of the Circuit Court of Appeals against the Respondent. We submit for the careful consideration of the Court the question as to whether the validity of a patent of such very great public importance should be finally determined by the changed opinion of one judge.

2. Respondent's brief is so phrased (pp. 5, 27) as to carry the unmistakable meaning that all of the tribunals of the Patent Office and the Court of Appeals of the District of Columbia were unanimous in awarding priority of invention to Langmuir, the patentee, in the interference proceedings between him and Dr. Arnold of the Western Electric Company. The various holdings in the Patent Office are set forth on page 6 of the petition. The ultimate tribunal in the Patent Office—the Commissioner of Patents—found in favor of Arnold, and his opinion so intelligently deals with the question of priority and so thoroughly points out the unsoundness of the decisions of the lower tribunals that we have had the same printed as a separate pamphlet with a blue cover, and submit it herewith. It thus appears that the Commissioner of Patents, Judge Moore (who heard and saw the witnesses), Judge Wooley on two occasions, and Judge Davis on one, have awarded priority of invention to Arnold. Opposed are the opinions of the two lower tri-

bunals in the Patent Office (diametrically opposed in their theories), the opinion of the Court of Appeals of the District of Columbia, which professedly adopted these diametrically opposed positions, and the last decision of the Court of Appeals which does not mention the subject of priority.

3. In order that undue significance may not be given to the finding of patentable invention by the Law Examiner of the Patent Office—which finding is given prominence in Respondent's brief—it should be pointed out that the question of patentable invention had been raised by Dr. Arnold during the pendency of the interference proceedings; but before it had been disposed of, a license agreement had been entered into between the American Telephone & Telegraph Company and the General Electric Company, and, thereupon, the Examiner was so notified. The question of patentable invention was accordingly not argued on behalf of Arnold but the brief which had been prepared prior to the license agreement was submitted. Consequently, to all intents and purposes, this question when considered by the Law Examiner was academic. This question having been settled by the Law Examiner without further opposition by Arnold, it was not open to any of the other tribunals of the Patent Office for consideration. If it had been, the opinion of the Commissioner indicates that he would not have found invention. Certainly, he would not have found invention on any such basis as that on which the majority opinion of the Circuit Court of Appeals places it. Indeed, the Law Examiner did not find invention on any such theory as that adopted by the majority opinion of the Court of Appeals. As was said by the Commissioner, "the line between the prior art and the issue is attenuated and if there is patentability, it must be as set out in the decision of the Law Examiner on the motion".

4. On page 27 of Respondent's brief, the statement is made that Judge WOOLLEY was incorrect in stating that the evidence before Judge MORRIS was substantially more favorable to Arnold's contention than the evidence before the Patent Office tribunals. Judge WOOLLEY was absolutely right. The whole interference record (which comprised the evidence before the Patent Office tribunals) was introduced by stipulation before Judge MORRIS. In addition, there was produced on behalf of the petitioner, the following evidence which was not before the Patent tribunals, *and the failure of the record to contain such was the main ground upon which the Board of Examiners-in-Chief in the Patent Office awarded priority of invention to Langmuir.*

Robert A. Milliken, one of the foremost physicists of the world, testified that *he had taught Arnold to do the very thing that the Board of Examiners-in-Chief held they were not satisfied from the evidence before them that Arnold knew how to do.* According to their explicit statement, the absence of such evidence was the only circumstance which prevented them from awarding priority to Arnold. In this respect, Dr. Milliken was corroborated by Dr. Jewett, Vice-President of the American Telephone & Telegraph Company in charge of the Department of Research and Development, and Dr. Colpitts, Assistant Vice-President of the Telephone Company and in charge, under Dr. Jewett, of the Department of Research and Development.

The question of conception of the alleged invention and the reduction to practice thereof by Dr. Arnold were gone into far more thoroughly than in the interference proceedings; many days and hundreds of pages being devoted to these subjects. The only person acting in a judicial capacity in this entire controversy who ever saw and heard the witnesses was Judge MORRIS, and he decided the issue of priority in favor of Arnold.

The testimony of Dr. Becker and Dr. Kelly given in open court before Judge Morris was entirely new, compared with the case in the Patent Office, and thoroughly rebutted Langmuir's pretense of having made the invention in 1912, on the dates assumed for him by the Patent Office tribunals that had decided in his favor.

5. Respondent's brief states (p. 4) that the issue of priority was not one of fact. If Judge Morris believed the testimony given in open court by Dr. Milliken, Dr. Jewett, Dr. Colpitts and Dr. Arnold, not even the Respondent can deny that he must have found Arnold was the prior inventor. Indeed, Respondent in its brief before the Circuit Court of Appeals contended that these men were not entitled to credence because they were testifying from memory. If there was not thus presented a question of fact, it is difficult to conceive when such an issue can be presented.

6. On page 5 of Respondent's brief, there is a quotation from the opinion of Judge Buffington wherein he refers to the subject matter of the patent in suit as a tube "known commercially as the Langmuir tube". The tube of the Langmuir patent has never been known commercially as the Langmuir tube. This is pointed out in Judge Woolley's opinion (p. 46 of the pamphlet submitted with petitioner's petition and brief) where he states that "plaintiff frankly admitted at the argument" that this name had not been given to the tube by the art.

Respectfully submitted,

Thomas G. Haight,
Samuel E. Darby, Jr.,
Counsel for Petitioner.

PETITIONER'S BRIEF

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CHARLES ELMORE CR

Supreme Court of the United States

October Term, 1930.

No. 630.

DEFOREST RADIO COMPANY,
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vs.

GENERAL ELECTRIC COMPANY,
Respondent.

BRIEF FOR PETITIONER.

THOMAS G. HAIGHT,
SAMUEL E. DARBY, JR.,
Counsel for Petitioner.

CARL A. RICHMOND,
WILLIAM R. BALLARD,
Of Counsel as to "Point III" and the related part of "Point V" only.

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DEFOREST RADIO COMPANY,
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BRIEF FOR PETITIONER.

Opinions of the Courts Below.

This is a patent infringement suit.

Judge MORRIS in the District Court of Delaware rendered an opinion which is reported in 23 Fed. (2) 698[1] holding that the patent in suit was invalid on three distinct grounds.

(1) Because of anticipation and want of invention; a question of mixed fact and law.

(2) Because of prior invention, if invention in fact existed;—*a question of fact.*

(3) Because of prior public use—*a question of fact.*

NOTE. Italics on quotations are ours, unless otherwise stated.

[1] Rec., Vol. 3, p. 1943.

Appeal was taken to the Circuit Court of Appeals for the Third Circuit, and that Court affirmed the decision of the District Court in an unreported *per curiam* opinion *which adopted the opinion of Judge Morris*, Judge BUFFINGTON dissenting *without opinion*.

Thereafter, a petition for rehearing was filed and granted, and the case was reargued.

In an opinion written by Judge BUFFINGTON reported in 44 Fed. 2nd 931 [2] the majority of the Court reversed the District Court without referring to or discussing the findings of fact of the District Court, and entered a judgment accordingly. Judge WOOLLEY wrote an extensive and carefully considered dissenting opinion upholding the conclusions of the Trial Court, 44 Fed. (2nd) 938.[3]

Jurisdiction.

The case is here on writ of certiorari granted by this Court on February 25, 1931; the jurisdiction having been invoked under Section 347, U. S. Code, Title 28.

Assigned Errors to Be Urged.

(1) The Court of Appeals erred in reversing the decree of the District Court and holding the Langmuir patent No. 1,558,436 to be valid and infringed.

(2) The Court of Appeals erred in failing to hold that the Langmuir patent No. 1,558,436 is invalid because of anticipation, want of invention, and double patenting.

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[2] Rec., Vol. 3, p. 2026.
[3] Rec., Vol. 3, p. 2043.

(3) The Court of Appeals erred in failing to hold the Langmuir patent No. 1,558,436 invalid because of prior invention by H. D. Arnold.

(4) The Court of Appeals erred in reversing the dispositive findings of fact of the Trial Court, based on conflicting testimony as to prior invention by H. D. Arnold.

(5) The Court of Appeals erred in failing to hold the Langmuir patent No. 1,558,436 invalid because of prior knowledge and public use by Lee DeForest and the Federal Telegraph Company.

(6) The Court of Appeals erred in reversing the dispositive findings of fact of the Trial Court, based on conflicting testimony as to prior knowledge and use by Lee DeForest and the Federal Telegraph Company.

Statement of the Case.

Subject Matter Involved in the Case.

This suit was brought by the Respondent, General Electric Company, against the DeForest Radio Company, alleging that the radio vacuum tubes made and sold by the latter were an infringement of Langmuir patent No. 1,558,436, issued October 20, 1925.

The "tubes" in question are the now well known vacuum tubes universally used in radio broadcast receiving sets, and in this record are variously referred to as "vacuum tubes", "electron discharge devices", "audions" and "valves". They comprise an evacuated glass bulb containing two or three metallic electrodes—usually three—which

are connected in appropriate electrical circuits with suitable sources of current to produce the desired effects.

The two-electrode vacuum tube, for use as a wireless detector, was invented by Fleming and covered in his U. S. patent No. 803,684, which expired November 7, 1922.

The three-electrode vacuum tube or "audion" was the invention of DeForest for which he obtained patent No. 879,532 which expired February 18, 1925. The difference between the three-electrode tube and the two-electrode tube is by no means represented by the difference between two and three. The two-electrode tube gave the electrical art a current flow across a vacuous container, which accomplished certain useful purposes because of its characteristics. The introduction of the third electrode, however, gave the art, for the first time in history, a means for controlling a flow of current which was at once inertia-less and consumed practically no energy in the control circuit and capable of producing any desired variations in the discharge current with absolute fidelity.

The parties to this case are in agreement that the three-electrode tube involving this new principle of operation, revolutionized the electrical arts. It is the thing which is used in modern broadcasting systems for generating the radio waves, for modulating them in accordance with the speech or music, for "detecting" them in the receiving sets and for amplifying them at both sending and receiving ends.[4] It is used in wire transmitting systems, both tele-

[4] A vacuum tube *detector* is one which receives current of one type or character, *e. g.*, oscillating or alternating current, and gives out current of a *different* type or character, *e. g.*, a pulsating direct (unidirectional) current; in radio it changes radio frequency currents to audio fre-

phone and telegraph, for a number of purposes. It is employed both in recording and reproducing talking motion pictures, in the production of modern phonograph records, and in a number of other commercial fields.

What the Patent in Suit Purports to Cover.

The patent in suit purports to cover an improvement in the vacuum tubes of Fleming or DeForest, and, according to Respondent, consists in removing more of the air from the tube during manufacture than was done by Fleming or DeForest, *i. e.*, in getting a higher vacuum. It is not claimed that *all* of the air is removed, because that is impossible, but that enough is removed so that what remains will not interfere with the operation of the tube. Respondent's position is, indeed, that any DeForest audion (except a "detector" tube), which properly performs its intended function, is covered by the Langmuir patent. The exception in favor of the "detector" tube is because of the fact

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quency currents. In other words, the current which is passed through the tube is *altered* as to its character so that it can be "detected" by certain kinds of instruments. Thus, certain operational characteristics of a vacuum tube are made use of, when the tube is to be employed as a *detector*, which are *not* made use of when the tube is to be employed for another use, for example, as an *amplifier*. A *detector* is not as much concerned with *power output* as it is with the needed change in *character* of the output to make a feeble current perceptible.

The vacuum tube *amplifier*, on the other hand, is not concerned with detection, and its principal, if not sole function is to produce on the output side of the tube, current in the *same* form and of the *same character* as that received on the input side thereof, but in a greatly strengthened or *amplified* condition.

that the "detector" action of a tube is in some respects better when the vacuum is relatively poor. Respondent itself, at least until recently, has purposely made its detector tubes with a definite gas content. This distinction between detector tubes and amplifier or oscillator tubes has an important bearing on questions in this case, as will appear later.

The Langmuir patent was applied for October 16, 1913, and issued October 20, 1925. In the year 1915 and again in the year 1916 the application stood allowed and Respondent might have taken the patent out by simply paying the final fee within the six months allowed by law. It chose, however, to forfeit and renew the application on the first occasion, and the case was reopened for further amendment on the second occasion. The interference proceeding with the Arnold application, which came later, (and which will be hereinafter discussed, *post*, pp. 14, 56) would have been between Arnold's application and the Langmuir *patent* if Respondent had taken out the patent when allowed, and so would not have delayed its issue or postponed the running of its seventeen year term.

From July 1, 1920, on, the General Electric Company held an exclusive license for certain purposes under the DeForest vacuum tube or "audion" patent above referred to, and was very active in prosecuting infringers in its exclusive field which included the sale of radio broadcast receiving tubes to the public. That DeForest patent expired in February, 1925, as above noted. The Langmuir patent was brought out in October, 1925, and Respondent started this suit against the DeForest Company in January, 1926. If the Langmuir patent is valid it extends the vacuum tube monopoly, which Respondent was enjoying under

the DeForest patent up to 1925, for an additional seventeen years.

The application of the patent in suit as filed in October, 1913, did not ask for a patent on a vacuum tube of any kind. The invention which it claimed was *a particular method of exhausting* vacuum tubes; a method, moreover, which is now admitted to be inoperative.

Besides this inoperative method the application also described procedure which *was* operative to produce a very good vacuum. This procedure in its entirety is also disclosed in patents and publications prior in date to the application, as we shall see, although it is doubtful whether Langmuir knew that fact. The application further described the characteristics of a discharge through a vacuum where the residual gas is reduced to the point where it does not affect the result,—a discharge frequently referred to as "a pure electron discharge". Such a discharge and its characteristics also were described in prior patents and publications, although it is doubtful whether Langmuir knew this.

Scientific Principles Involved.

Some understanding of the difference between a pure electron discharge and one affected by the residual gas, and of the methods for obtaining high vacuua, are necessary to a consideration of this case and we shall explain each briefly. These are matters of scientific fact and not in dispute.

If we have an evacuated glass tube into which are sealed two metal electrodes connected to the poles of a battery or other source of current, no current will flow through the tube under any ordinary voltages (electric pressure). If

we heat one of the electrodes, which can be done, for example, by making it in the form of a filament and passing a current through it as in an electric lamp,—a current *will* flow across the space in the tube and through the wires connecting the electrodes to the battery, if the hot electrode is connected to the negative pole. This is because the heat causes "electrons" to be liberated from the surface of the hot electrode and these are drawn across the space under the influence of the electrical pressure between the two electrodes. *These electrons constitute the electric current.* They are minute *negative* charges of electricity. The amount of the current depends upon the number drawn across the space. The number drawn across (assuming a sufficient supply) depends upon the voltage applied to the two electrodes. With a higher voltage more electrons go across and they move faster. If gas molecules are floating around in the tube, some of them will be hit by the electrons which are flying across toward the positive electrode, and if the voltage applied to the electrodes is greater than a definite amount (15 to 25 volts depending on the kind of gas in the tube) the electrons will be going fast enough to split up the gas molecules. This is called "gas ionization", so named because when the electron hits the molecule it splits it into two parts, an electron (quite like the one that did the hitting) and a much larger and more slowly moving part called an "ion" which carries a *positive* charge of electricity. The amount of gas ionization which occurs in a given tube depends mainly upon two things, (1) the number of gas molecules in the space and (2) the applied voltage. Increasing either the gas content or the applied voltage will increase the amount of ionization. With a given state of vacuum

and voltage, the amount of ionization will not be changed by increasing the voltage if the gas content is suitably reduced, or by increasing the gas content if the voltage is suitably reduced.

Ionization and Its Effect.

The effect of ionization on the discharge is in general to increase it,—not because the resulting positive and negative charges carry any considerable amount of current—but because the positive ions act like traffic police for the electrons which do constitute the current, and facilitate their passage. With no positive ions present the electrons which are boiled out of the hot filament crowd together in the immediate neighborhood of the filament, repelling one another (because they are all negative) so that some may even be forced back to the filament. Thus the number getting across to the positive electrode in a given time, is held down in much the same way that the progress of a person coming out of a crowded theater is slowed down. This effect of the crowd of negative electrons upon their own movement is called the "space charge" effect (sometimes called "volume charge"). But with any considerable number of positive ions (ionized gas molecules) present, this negative space charge is greatly reduced inasmuch as positive and negative charges neutralize each other, thus permitting the electrons freely to pass across to the opposite electrode.

This "policing" of the electrons by the ionized gas molecules sounds like a very desirable thing, and in some cases it is (in detector and rectifier tubes, for example); perhaps it would always be desirable if the "policemen" were reliable and uniform in performing their duties. For

reasons which need not be here stated, however, the gas content in a tube, and so the amount of ionization, varies with temperature, the life of the tube and other things, so that erratic and undesirable operation may result. Moreover, in the *three*-electrode tube the characteristic operation is due to the control over the discharge which the third electrode—the "grid", exercises by more or less neutralizing the "space charge". Obviously then, much gas ionization in a DeForest tube might be expected to interfere with the desired effect.

In general, it is clear from the foregoing that the amount of the gas residue permissible in any particular tube depends upon the use to which the tube is to be put and the voltage under which it must operate.

The Methods of Getting High Vacuum.

As to the methods for getting vacua high enough for tubes of the kind here considered, the patent in suit points out that two things are necessary, first a good vacuum pump (the "Gaede molecular" pump is suggested), and second a thorough heating of the glass walls and metal electrodes to drive out the gas occluded in their surfaces so that it can be drawn off by the pump. The glass walls can be heated sufficiently by baking the tube in an oven during the exhaust. The filamentary electrodes are heated by passing a current through them until they glow. The other electrodes are heated by "bombardment". This term is used to describe the impact of the electrons upon a positive electrode when they fly across the space under the influence of an applied voltage, as above described. Millions of these, striking the electrode in this way, raise its temperature just as the blows of so many tiny hammers would.

These requirements for producing a high vacuum and all of these expedients for producing the necessary heat are repeatedly disclosed in publications and patents antedating Langmuir's work, as we shall point out later.

We may note here in passing that the invention claimed in his application when it was filed in the Patent Office, to which we have referred above, was the idea of freeing an electrode of gas by *bombarding without heating*. Afterwards Langmuir discovered that this was a mistaken idea, and that the only way to remove occluded gases is by heating, and that bombardment is effective only as it *heats* the electrode, just as the prior art had disclosed. Consequently, claims to this original idea were cancelled.

Lastly, it is to be noted that the patent further points out (p. 4, line 109) that the amount of heating required in the exhausting process, and specifically the voltage required in the bombarding, depends upon the voltage to be applied to the tube in the circuit where it is to be used. Some of the patent claims assert that a tube operating without ionization effects, at only 40 volts and carrying very minute currents (1/10 of one milliampere), comes within the supposed invention. Others specify voltages all the way up to 200, and much heavier currents.

History of the Langmuir Application.

Although the Langmuir application as filed claimed as its invention the impossible and scientifically absurd method of gas freeing, viz.: *bombardment without heat*, the patent issued for an entirely different thing—the vacuum tube itself, assertedly differing from tubes of identical structure only in operational characteristics in use. We in-

vite the Court's attention to the history of the Langmuir application in the Patent Office.[a] Space forbids our following, step by step, the continuing and radical changes that occurred in the specifications and claims, which involved the cancellation of all of the claims originally presented and the substitution of claims for an entirely different thing; and, in some instances, for a diametrically opposite thing; and continual addition to the specification to keep the application abreast of Langmuir's education in the art. On this phase of the matter, we direct attention to the summary contained in the dissenting opinion of Judge Woolley, as follows:[b]

> "A recital of the prosecution of a patent application through the Patent Office is dreary reading yet, in this instance, it shows quite clearly that even the applicant was far from certain what he had invented. Naturally I hesitate to say this about Irving Langmuir, a great physicist, yet, saying it with entire respect, I am convinced that the history of the application establishes that fact and therefore is pertinent to the ever present inquiry: What did Langmuir invent?
>
> The patent issued on October 20, 1925. The application was filed on October 16, 1913; renewed March 14, 1916. These are critical dates. The original application contained five claims; two for process of removing ionizable gas from vacum electron discharge devices, that is, in plain words, for obtaining a high vacuum, and three for methods of preparing such devices, and no claims for discharge devices themselves. The specification conformed to these claims, referred to the art, stated the problem, dis-

[a] Rec., Vol. 6, pp. 660-773.
[b] Rec., Vol. 3, p. 2044.

closed construction adapted to the operative principle of such tubes and showed how they can be 'evacnated' of gases by heating the glass walls, heating and bombarding the metal parts thereby expelling occluded gases, and drawing off both free gases and expelled gases 'by a suitable evacuating means, for example, a Gaede molecular pump'.

It should be noted that when the application was filed in 1913 the radio art was in its infancy but that, in 1925, when the patent issued, the art had attained an amazing growth. It is pertinent to inquire what happened to the application during this span of twelve years during which the mysteries that had enveloped the early art were largely dispelled and replaced by a broad knowledge of its principles.

After the application was filed in 1913 it lay practically dormant for several years, the applicant filing enough amendments by additions and cancellations to keep it alive. Amendments to the specification occurred as follows: two in 1913; eight in 1914; one in 1915; five in 1916; three in 1917; three in 1919 and forty-five in 1925, the year the patent issued.

Amended claims were filed and additions thereto and cancellations thereof made as follows: four in 1913; fifteen in 1914; twenty in 1916; five in 1917; nine in 1919; five in 1921 and forty-two in 1925, the year of the patent.

Analyzing these amendments, it appears that the five original claims (which were for process and method) were at different times wholly cancelled. Late in the year 1913 Langmuir first made claim to invention of a structure or device, that is, to invention of a tube. This he did by four claims. The first was amended four times and cancelled in 1925. The second also was amended four times and cancelled in 1925. The third was amended four times and was

not cancelled. The fourth was amended once and cancelled in 1925. Of the thirty-two claims allowed in the issued patent, four are for method and process, being amplifications of the original method and process claims cancelled; twenty-eight are for a device. Of these device claims one was filed by amendment in 1913; one in 1917; nine in 1919; three in 1921 and fourteen in 1925, the year the patent issued. Bearing on the question whether Langmuir knew and disclosed in 1912, or indeed in succeeding years, what he had invented, it is significant to note that during twelve years, and mainly in the latter part of that period when the art had grown and reached a high stature, he rewrote, by sixty-seven amendments, the major part of his specification and cancelled all the original method and process claims and by one hundred amendments added, changed and cancelled claims until finally he was allowed the thirty-two claims of which twenty-eight, the claims for a device, are entirely new. It would be instructive, yet impossible within the permissible bounds of an opinion, to trace the progressive changes from the method and process claims of the original application to the device claims of the matured patent."

There is, therefore, a striking analogy between the file history of the Langmuir patent and that of the McMichael patent considered in *Powers-Kennedy Constructing Corporation, et al.* v. *Concrete Mixing and Conveying Company*, decided December 15, 1930, by this Court.

Arnold Interference.

As the result of an application for a patent filed on November 2, 1915, by Dr. H. D. Arnold, an engineer employed by the Western Electric Company, an interference

was declared between the Langmuir application and the Arnold application. This interference was carried through all of the Tribunals of the Patent Office, resulting, as will be hereinafter set forth in detail,[7] in various holdings, and finally in an award of priority of invention to Langmuir by the Court of Appeals of the District of Columbia, overruling the Commissioner of Patents. The evidence in the present case has been extended to include certain specific evidence, the absence of which was assigned as ground for such award to Langmuir. The application of Arnold was admittedly filed to provoke an interference because, shortly before the application was filed, the engineers of the Western Electric Company and the American Telephone & Telegraph Company had learned of Langmuir's application and they felt, if the subject matter thereof was patentable, that Dr. Arnold was the first to invent it. Up to that time, it had not occurred to Dr. Arnold that the subject matter was patentable and, in the interference, he moved to dissolve on that ground, and six of seven claims were stricken out on his motion. We point out in passing that Dr. Millikan, the foremost of American physicists, when he learned that Langmuir was attempting to patent a high vacuum tube, advised the engineers of the Telephone Company that it was their duty to the public to provoke the interference, because he did not believe that any such thing was patentable.[8]

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[7] *Infra*, pp. 56 *et seq.*

[8] Interf. Rec., pp. 874 to 876 and context.

The "Interference Record" is the record made up in the Patent Office for the Court of Appeals of the District of Columbia for the priority contest between Dr. Langmuir the present patentee and Dr. Arnold of the Telephone Company. This "Interference Record" is an exhibit in the present case and was stipulated as evidence in this case at Rec., Vol. 1, page 133.

Summary of Argument.

1. The patent discloses nothing new or patentable over the prior art. Long before Langmuir's earliest claimed date of conception, the art was fully familiar with pure electron discharge devices claimed by the patent, as well as all of the methods and means for producing the high vacuum necessary for such tubes. Indeed, the prior art structures are admittedly identical with those of the Langmuir patent, and the only difference therefrom asserted by Respondent is in the degree of evacuation of said devices. The invention at the most, therefore, is merely for a difference in degree, which this Court has from the earliest times held is unpatentable.

2. The majority opinion of the Court below sustained the patent on an untrue definition of the alleged invention. After Respondent abandoned its original claim that the invention was a new method of producing high vacuum, it thereafter advanced in the Patent Office and in the Courts several different definitions of the invention; always seeking to escape the legal effect of a finding that the invention was merely a difference in the degree of vacuum. Finally, after the District Court had decided that the patent was invalid, and the Circuit Court of Appeals had affirmed that decision, Respondent brought forth an entirely new definition different from anything that it had theretofore suggested. This definition the majority of the Court below on reargument accepted, and its decision is based thereon. The new definition is unsupported by the evidence and is contradicted by the testimony of the patentee himself.

3. If the subject matter of the patent in suit involves patentable invention, then Dr. Arnold was the first inventor thereof and not Dr. Langmuir, the patentee. Whether the invention be that which the defendant variously defined in the Patent Office and before the Courts until the rehearing in the Circuit Court of Appeals, or whether it be in accordance with the definition advanced on the reargument, the evidence conclusively establishes that Arnold was prior to Langmuir in date of conception, in reduction to practice and in the production of commercially useful articles. His claim to priority has been established by the Commissioner of Patents, by Judge Morris, who heard and saw the many witnesses who were called on this point, and by the majority of the Circuit Court of Appeals before the reargument. Langmuir was awarded priority by the Examiner of Interferences upon an untenable proposition of law which the Respondent has never subsequently asserted, and by the Examiners-in-Chief because they gave Langmuir an early date of conception, which conception he admits in this case he did not have at that time, and because they did not believe that Arnold knew how to get a high vacuum at the time they found he conceived the invention. In this case it has been shown that Arnold *did* know how to get the high vacuum. Langmuir has also received an award of priority from the Court of Appeals of the District of Columbia, which overruled the Commissioner of Patents on an opinion which simply adopted the opinions of the Examiner of Interferences and the Board of Examiners-in-Chief. These opinions, however, were as far apart as the poles on the legal principles relied upon and the facts found. Judge Morris, the only judge who heard and saw the witnesses, has decided in favor of Arnold.

4. The patent is invalid because of prior knowledge and use. The claims variously describe the patent as a tube capable of operating without harmful effects of ionization with an impressed voltage of 40 volts or more. The uncontradicted testimony in the case is that Dr. DeForest, while employed by the Federal Telegraph Company in California in 1911 and 1912, used tubes as amplifiers, employing voltages considerably in excess of 40 volts, without harmful ionization. The use of such tubes with such voltage as amplifiers would be impossible if ionization in any appreciable amount existed. The preparation and use of the tubes with this vacuum was deliberate and intentional on the part of Dr. DeForest.

5. The present majority decision of the Court of Appeals has reversed the dispositive findings of fact of the Trial Court without expressing any reason therefor, and without mention of those facts. Either prior inventorship on the part of Dr. Arnold or prior knowledge and use on the part of Dr. DeForest—*both questions of fact*— was a complete defence to this suit. Judge Morris heard and saw the witnesses who testified on the priority of invention issue. While he did not hear those who testified on the prior use, their testimony was not attacked, except by inferences sought to be drawn therefrom by experts whom Judge Morris saw and heard on the stand. The rule is that where a question of fact depends upon conflicting testimony, or upon the credibility of witnesses, the finding of the judge who saw the witnesses will be treated as "unassailable", unless clearly wrong.

6. The patent is invalid because of double patenting. Respondent caused to be issued to it, on October 31, 1916, a

patent covering an invention made by one of its engineers, Dr. Coolidge, claiming the same invention now asserted for the Langmuir patent, which Respondent likewise caused to be issued to itself. The Coolidge application was filed before the Langmuir application and the Coolidge patent issued before the Langmuir patent. The later patent is therefore invalid.

ARGUMENT.

POINT I.

The patent discloses nothing new or patentable over the prior art; the difference is only in the degree of vacuum to be used for specific purposes.

To deal with the question of patentability it would be most helpful if we had a clear definition of the alleged invention. As above noted, difficulty has been experienced throughout this case in finding any definition which will serve the purpose. The Respondent's eleventh-hour definition is clearly a failure for reasons to be stated. The claims of the patent in suit, which should serve as the needed definition, signally fail to do so. One cannot read these thirty-two claims through without becoming altogether bewildered.

We shall meet this situation, therefore, by showing that everything within the four corners of the disclosure of the Langmuir patent is to be found in the prior art. And in doing this we shall refer primarily to the Langmuir application *as it was filed in the Patent Office*, for it is well set-

tled that valid claims cannot be based upon new matter added after filing.[1] This rule is so well recognized that it needs no argument, but it is important to note the fact here because the Langmuir application was so extensively amended after filing as to be scarcely recognizable.

What Langmuir Disclosed to the Patent Office as the Alleged Invention.

Looking then to the original application, we find that it described first a process of making vacuum tubes. Briefly stated, this process is the exhaustion of the enclosed space by some efficient vacuum pump, together with heating of the glass, glowing of the filaments and bombarding of the electrodes so as to drive out the occluded gases from these parts.[1a] In short, it is simply an evacuation which includes evacuation of the surfaces of the walls and electrodes as well as of the free gases. The specification states that this shall be carried to a point depending upon the discharge which it is expected to put through the tube when in use, *i. e.*, the voltage to be applied.

So much is said in this record about the importance of a "high" vacuum that we should expect to find something definite in the disclosure as to what this means in relation to the present alleged invention. We find in the specification of the patent nothing more definite than this,

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[1] *Railway Co. v. Sayles*, 97 U. S. 554, 563; *Eagleton Co. v. West Co.*, 111 U. S. 490, 498; *Kittle v. Hall*, 29 Fed. 508, 513.

[1a] This process was not claimed in the original application, but an alternative process, "bombardment without heating", was also described *and claimed*. Later this was acknowledged to be futile and such claims were canceled.

"The evacuation of the device should be preferably carried to a pressure as low as a few hundredths of a micron, or even lower, but no definite limits can be assigned".[2]

Respondent takes the position that the limiting pressure is far more uncertain than even this statement would indicate. Dr. Saul Dushman, an associate of Dr. Langmuir in the Research Department of the General Electric Company, states in his book on "High Vacuum" that "a pressure of 0.01 bar (0.0075 micron) is a maximum pressure for the efficient operation of a hot cathode high vacuum device".[3] This limiting pressure assigned by Dr. Dushman is less than a single hundredth of a micron.

On the other hand, one of Langmuir's tubes on which he is compelled to rely in his effort to anticipate the date of invention proved for Arnold, was admitted by him to have a pressure of 0.4 microns of gas, that is, *40* hundredths of a micron.[4]

It is apparent how vague and uncertain is the patent as to the degree of the vacuum required. The invention cannot be the *degree* of vacuum.

Attainment of High Vacuum in the Prior Art.

Neither can the invention be the procedure Langmuir describes for attainment of a sufficient vacuum. It was widely and thoroughly understood long before Langmuir, that to get a good vacuum required more than mere pumping,—that it required heat treatment of all the interior surfaces of the vessel pumped, in order to free the occluded

[2] Rec., Vol. 4, p. 6, lines 3-6.
[3] Rec., Vol. 3, pp. 1655, 1656, Hogan XQ's. 349, 349a, 353.
[4] Rec., Vol. 2, pp. 1302, 1304, XQ's. 257, 267.

gases therefrom so that they could be evacuated by the pump. This requirement is clearly set forth in the Dwyer U. S. patent No. 59,654 of 1898.[5] This patent states, at line 19 of the first page of the specification:

> "A partial or incomplete vacuum, but one not carried sufficiently high to serve the purposes of the best grade of incandescent lamps, is readily obtained by a good mechanical or mercurial pump, *but it is in the removal of the residual gases remaining after such exhaustion that the greatest difficulty is encountered,* since that part removed by each stroke of the pump or by the successively falling drops of mercury in the case of the Sprengel pump, becomes continually smaller and smaller, being simply a certain fraction of the expanding remaining gases; and soon a limit is reached, which is, however, still below the desired vacuum, beyond which no further exhaustion by this means is possible. *To carry the vacuum still higher, it has been a common practice to heat the lamp-bulb by either an external source of heat,* such as a gas-flame, *or by an electric current passed through the lamp filament or by both of these means combined,* so as to expand the gases in the lamp, *and also to drive off from the lamp-filament itself and its supports,* more particularly the joint between the leading-in wires and the filament, which joint is usually made of some form of hydrocarbon paste, *gases occluded therein, while continuing the pumping operation.*"

This is also pointed out in the Soddy patent No. 859,021 of 1907 for "*Means and Apparatus for Producing High Vacuums*".[6] This patent states (p. 186, line 17)—

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[5] Deft's. Ex. 7, Rec., Vol. 5, p. 42.
[6] Rec., Vol. V, p. 186.

"In the production of high vacua not only has the air to be removed, but also the gases occluded or condensed on the walls of the vessel being exhausted, and the electrodes or filaments or other contents of the said vessel, which condensed gases are given up slowly after exhaustion and if not removed during exhaustion cause the vacuum to deteriorate."

Again at line 96 the patent points out—

"*The heating and expelling of the condensed and occluded gases may be effected in any usual or suitable manner of expelling condensed and occluded gases from the walls and contents of vessels being exhausted.* The usual manner of effecting such an operation is to heat the vessel while it and its contents are subjected to the same treatment as they are subjected to in after years. In incandescent lamps, for example, an electric current is passed through the filament and *in X-ray bulbs electric discharge is passed between the electrodes during the continuation of the exhaustion.*"

It is here seen that long before Langmuir entered this field, the very method of gas freeing that he proposed, viz., pumping and thoroughly heating the interior parts, specifically including bombardment, and which he admits will produce a device of his invention, is recited as being standard practice in the art.

In a paper published in the year 1904, S. E. Doane stated with regard to incandescent lamp exhaustion,[1]

"The completed lamp must not only be free from gases and vapors, but must also have had those parts capable of giving off gases and vapors thoroughly free from them. The only way we knew to accom-

[1] Rec., Vol. 5, p. 122, Deft.'s Ex. 11.

plish this was to highly heat everything we wished to free from gas."

Here again are stated, at a time long before the alleged Langmuir invention, the very things which the Langmuir patent says will obtain the desired vacuum.

Compare the foregoing authorities of the prior art with the following statement in the Langmuir patent itself:[8]

> "For the evacuation of the device the glass walls of the tube are carefully heated to as high a temperature as the glass will stand without softening, and in general the most approved methods of incandescent lamp exhaust are used."

It will be seen that the requirement of the patent in suit is fully satisfied by the foregoing references, Doane, Soddy and Dwyer of the prior art.

Another prior art authority to the same effect is Bessel-Hagen. In 1881 he set forth clearly that thorough evacuation meant getting the gas out of the electrodes and glass walls as well as out of the space within those walls.[9]

Heating of the walls and electrodes as a means to this end is described in no less than ten of the prior articles and patents.[1]

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[8] P. 4, lines 60 *et seq.*

[9] Rec., Vol. 5, p. 15.

[1] These are in Vol. 5 of the Record as follows: Bessel-Hagen in 1881, p. 16; Edison patent in 1889, p. 37; Duncan in 1896, p. 47; Dwyer patent in 1898, p. 42; Lenard in 1900, p. 62; Doane in 1904, p. 122; Merritt patent in 1909, p. 138; Soddy patent in 1907, p. 181; Friedrich patent applied for in 1910, p. 309 (Ex. 24); and Lilienfeld in 1910, p. 315.

Bombardment by a discharge through the tube as a means of heating electrodes, for the purpose stated in the foregoing quotations, particularly the quotation from Soddy, is described in at least six of the prior articles and patents.[3]

Langmuir himself made the unqualified general admission

> "that prior to 1912, there were some experimenters who took precautions to remove gases from the walls of vessels and from electrodes".[5]

Although the Law Examiner of the Patent Office adjudged that the Langmiur application had patentable subject matter, he distinctly denied that it lay in any method of attaining the necessary vacuum. He said:[4]

> "An evacuated tube having therein an incandescent electron-emitting cathode and an anode was old prior to the filing of Langmuir's application, and methods of attaining high vacua, sufficient to give a relatively pure electron discharge in a properly designed tube, were also well known and available to persons skilled in the art."

Clearly, there is nothing new in the method of getting the vacuum,—nor in the idea of a vacuum which will stay good in use.

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[3] These are in Vol. 5 of the Record as follows: Duncan in 1896, p. 47; Lenard in 1900, p. 62; Doane in 1904, p. 122; Soddy patent in 1907, p. 181; Hupka in 1909, p. 241, and Lilienfeld in 1910, p. 315.

[5] Interf. Rec., p. 1287.

[4] Interf. Rec., p. 2468.

Absence of Novelty in the Characteristics of a High Vacuum Discharge.

We find also that the original specification defines, to some extent, the character of the thermionic discharge through a well-evacuated tube. But the *discharge*, itself, even if new in kind, cannot be the invention because it is neither an "art, machine, manufacture or composition of matter" which are the only things patentable under the laws of the United States.[5] The discharge, whatever its nature, is merely a physical phenomenon.

Besides, it was not new,—and it will be well to keep this in mind because Langmuir and Respondent's counsel have a way of referring to his "new type of discharge" as if this were really new.

The characteristics of the discharge named in the original specification [6] are found on page 3, lines 11 to 27 of the patent as issued, and are given, as it says, "In order to distinguish electron-discharge devices made in accordance with my invention from the prior art, * * *" (p. 1, line 25). These are;

(1) Gas ionization absent or negligible,
(2) Cathode not heated by the discharge,
(3) No blue glow nor visible evidence of discharge,
(4) 3/2 power relation of current to voltage,
(5) Discharge independent of degree of vacuum within intended limit for the particular tube,
(6) Regularity and reproducibility.

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[5] Sec. 4886, Revised Statutes, Walker on Patents Fifth Ed., § 2, p. 2, Robinson on Patents, § 69, p. 105.

[6] Rec., Vol. 6, p. 662.

All these criteria are summed up in the simple statement that there must be absence of "harmful ionization", as this term was employed by Respondent's witness Hogan. His statement was:

> "How far that evacuation has to go in terms of pressure is not at all material. The important thing is to carry it to a point beyond which it is unnecessary to go in order to avoid the harmful ionization effects".[7]

The original DeForest audion gave a discharge having all the above listed characteristics when operated *in October, 1912,* below certain voltages, as is evident from the testimony of Jewett, Colpitts and Arnold, concerning DeForest's demonstration to the Western Electric Company.[8] *It could not have so beautifully amplified the weak speech currents if there had been any harmful ionization.*

Lilienfeld had discharges satisfying all these conditions as described in his 1910 paper.[9] Also such discharges occurred between the filament legs of incandescent lamps after "clean-up".[1]

Note that the six characteristics named are all inherent in the discharge in question and are interrelated. In general any one implies all of the others. If a thermionic discharge is without substantial ionization, all the other characteristics will be present. If the discharge is independent of the vacuum below a certain pressure of gas, the other

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[7] Rec., Vol. 1, p. 68.
[8] Rec., Vol. 1, p. 410, Q50; p. 497, Qs. 81, 82; p. 555, Q8.
[9] Deft's. Ex. 25, Rec., Vol. 5, p. 315.
[1] Rec., Vol. 2, p. 1348, XQ452.

characteristics will be present, and so on. Langmuir admits that Lilienfeld had thermionic discharges "substantially free from the effects of positive ionization";[2] also that he had discharges unaffected by further lowering of the gas pressure in the tube.[2a] Lilienfeld's discharges were at voltages of the order of thousands of volts.[3]

So the patentable thing cannot be the particular kind of discharge defined by the original specification since it is inherently unpatentable subject matter, and moreover was all old.

Respondent advanced the contention for the first time on the rehearing in the Court of Appeals, that the alleged invention lay in the substitution of a vacuum conductor for a gas conductor. We shall consider the prior art on this question at page 47 of this brief.

Physical Structure Not Novel:

The physical structure of the tube described in the original specification of the Langmuir patent is not the invention because it was old. The Petitioner's tube said to infringe is substantially the same physical structure as the old DeForest Audions, exhibited to the Western Electric Company in 1912. Compare, for example, Plaintiff's Exhibit 7, a sample of the alleged infringement with Defendant's Exhibit 139, the old DeForest tube. None of the patent claims deals at all with such details of structural difference as there are.

The simple fact is that an old DeForest audion pumped a little cleaner, especially as to the walls and electrodes, is

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[2] Interf. Rec., p. 1378 top; p. 1521 middle.

[2a] Interf. Rec., p. 1786 bottom.

[3] Hogan, Rec., Vol. 3, p. 1703, l. 11.

a tube of the Langmuir patent; no other change is necessary. There is no dispute about this,—it was admitted explicitly by the Respondent, as quoted on page 35 of this brief. No artful articulation of phrases characterizing the discharge through such a tube by one or another group of its inherent, natural qualities, can conceal this simple fact.

Lilienfeld Paper—

The Lilienfeld 1910 paper[4] above referred to, contains so complete and explicit a disclosure of all the structures, methods, functions and principles of the Langmuir patent in suit, that it deserves more detailed consideration. The paper begins with the statement that Lilienfeld wished to obtain the highest possible vacuum, and proceeds at great length to describe elaborate means for obtaining the extreme vacuum desired, including heating the filament and walls, electron bombardment, and the use of liquid air and charcoal to get out any residual gas. He describes the space (or volume) charge effect in the following language:

> "One can formulate more generally the conditions for high vacuum and large current density as follows: the production of a state in which the volume density of the electrons carrying the current is as large as possible compared with the density of gas molecules in which there exists, therefore, a tendency for the formation of the maximum possible volume charge in the path of current."

The space charge effect here disclosed by Lilienfeld was not mentioned in the Langmuir original specification, but it is a fundamental criterion in his patent, and is explicitly recited in numerous claims, for example, claims 10 and 12.

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[4] Rec., Vol. 5, p. 315, Deft.'s Ex. 25.

Lilienfeld states as a characterization of his device:

> "From a definite maximum density of the gas downwards the discharge phenomena are independent of the gas density in the region investigated."

This is, in simple language, Langmuir's fifth characteristic as above listed (*supra*, p. 26).

Again he states:

> "Now as a matter of experience it not only makes no difference at all whether the cathode is very strongly or feebly heated during the discharge provided, of course, that its temperature is high enough to insure its proper functioning."

This is a characteristic which has been much referred to by Langmuir in this litigation and is the basis of his patent claims 7 and 24.

Lilienfeld made readings of the current passing through his device and the potential across the sounding terminals that he employed, and he plotted his results and deduced his laws concerning the discharge. He made his plots logarithmically and one part of the curve follows the 3/2 power law, which he states thus:

> "More exactly formulated; the characteristic consists of two parts. In the first part the potential drop (gradient) increases as J 2/3, in the second as J 1/2. In both parts, the connection between J and V is represented simply by a power."

As pointed out in the Langmuir patent, page 2, lines 36, *et seq.*, expressing the law in terms of current (J 2/3) is identical with the 3/2 power of the voltage. Here we find

Langmuir's fourth characteristic as above listed, which is the criterion of the patent claims 6, 13 and 15.

It will be seen from the foregoing, therefore, that the Lilienfeld articles describe not only every treatment or process which Langmuir advances as necessary to produce his devices, but formulates the same laws, earmarks, or characteristics, by which a device so processed and treated may be identified when once produced.

It is unnecessary for *us* to speculate as to the effect of the disclosure of the Lilienfeld articles, for Langmuir has committed himself with respect thereto in the record of the case, as we will now show from excerpts of Langmuir's testimony. It is interesting to note in connection therewith that Langmuir, himself, disposed of Respondent's contention which apparently was accepted by the majority of the Court of Appeals, viz., that the term "high vacuum" as used today means something different from what it meant before Langmuir's time.

Langmuir testified with reference to Lilienfeld's work as follows:[5]

> "Lilienfeld proved beyond question, I think, that he obtained discharges, in some cases at least, in which the effects that he measured *were not dependent upon gas ionization* * * *.
>
> "Lilienfeld probably succeeded in obtaining a discharge in high vacuum *substantially free from effects of positive ionization* in the device he described in his 1910 paper * * *.
>
> "Lilienfeld in his experiments of 1910 heated the walls of the vessel, he reduces the gas pressure to a

[5] Interf. Rec., pp. 1378, 1521, 1784, 1786.

low value, and in some of his experiments he heated his electrodes by electronic bombardment * * *.

"Heating of glass and electrodes, and exhaustion to low pressure, are elements which were used by Lilienfeld and were known long prior to Lilienfeld's article * * *.

"Factor No. 1 which I gave in answer to XQ84, viz., that the bulb should be heated during exhaust to a temperature materially higher than the operating temperature, was used by Lilienfeld in much of his work * * *.

"Factor No. 4, which is that which I gave in the first part of my answer to XQ87, refers to the lowering of the pressure to such a point that a further lowering brings about no further change. In many of Lilienfeld's experiments, this condition was realized".

Fleming.

Respondent claims no structural difference between a tube embodying the Langmuir invention and the Fleming valve. Indeed counsel for the Respondent admitted in open Court in response to a question by Judge Morris that the only asserted difference between them was in the degree of evacuation.[6] The Fleming publications disprove the existence of even this difference.

Fleming, the inventor of the Fleming valve, published many statements as positive as anything we find in the Langmuir patent, to the effect that the very highest vacuum possible was to be desired in such vacuum tubes. In his article,[7] he states:

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[6] Rec., Vol. 3, p. 1528.

[7] Deft.'s Ex. No. 14, p. 144, Vol. 5, Rec.

"An ideal and perfect rectifier for electric oscillations may, therefore, be found by enclosing a hot carbon filament and a perfectly cold metal anode *in a very perfect vacuum.*"

He also states (p. 144):

"The bulb must be highly exhausted to about the pressure usual in the case of carbon filament incandescent lamps *and the metal cylinder or plate must be freed from occluded air.*"

In the Fleming patent No. 803,634,[8] it is stated (p. 158, l. 96):

"As a *very high vacuum* should be obtained in the bulb (*a*) and as a considerable quantity of air is occluded in the conductors, *these should be heated when the bulb is being exhausted.*"

In Fleming's article of 1906,[9] Fleming states (p. 167):

"Imagine a bulb of glass, made as in fig. 1 (see p. 165), containing two loops of platinum wire, or, better still, two carbon filaments."

This is the identical construction used by Langmuir in 1912, and which in the interference with Arnold he advances as embodying his invention. The Fleming article continues—

"*Let this bulb be exhausted as completely as possible, so that in it the highest attainable vacuum is made. To achieve this, the filaments must be heated to bright incandescence, while the exhaustion is going on.* Having done this, if the secondary terminals of

[8] Deft.'s Ex. 15, p. 157, Vol. 6, Rec.
[9] Deft.'s Ex. No. 16, p. 165, Vol. 5, Rec.

an induction coil are connected to the two separate filaments when cold, no discharge will take place across the vacuum between them; thus apparently showing that the space is a very perfect non-conductor.'

Again he states (p. 174):

"Let us define these conditions more closely. The vacuum is said to be low when the original normal air pressure in it is reduced to one-thousandth of an atmosphere, or it may be only one one three-hundredths. *It is said to be high when it is reduced to one hundred millionth of an atmosphere.*"

These Fleming articles are accurate descriptions of the Fleming valves which at the date of their writing were in actual use and have been used continuously since. The Court will readily recognize that the degree of vacuum specified by Fleming comes well within the most exacting limits advanced by Langmuir as embodying his invention. His one hundred millionth of an atmosphere is less than a hundredth of a micron, which compares favorably with the Langmuir patent's recital of "a few hundredths of a micron". The Court will further recognize that Fleming not only recognized the *desirability* of obtaining a high vacuum, *but recognized how to obtain such a vacuum.*[1] *The means for obtaining the high vacuum advanced by Fleming are the same as those described by Langmuir.*

Waterman's testimony to the effect that the Fleming valve had a very high vacuum and depended entirely upon

[1] Chaffee, Q123, p. 65, Vol. 1, Rec.

the electron flow and not at all upon the residual gas, will be referred to later (p. 49 this brief) in discussing Respondent's new definition of the invention. Accordingly we shall not quote it here. We may, however, call attention to the fact that Waterman's testimony was given from first-hand experience with Fleming valves. He stated that he was familiar with these tubes, having used some supplied to him by the Marconi Company (owner of the Fleming patent) which had obtained them from the British Marconi Company, by which they were manufactured under the Fleming patent.[2]

From the foregoing we think it clear that the Langmuir patent application, especially as filed in the Patent Office, disclosed no new kind of vacuum, no new method of obtaining a vacuum, no new ideas as to the effect of residual gases in vacuum tubes and no new physical structure for vacuum tubes. The most that can be said is that present-day vacuum tubes of the kind here said to infringe, are exhausted more completely than were DeForest's early tubes, in order that they may meet present-day commercial requirements as to voltage and methods of use. That this is the limit to what can be said was conceded by counsel for Respondent in its brief before the Court of Appeals (p. 30) at the first argument in the following words:

> "On the other hand, the invention may be realized by "producing and maintaining", as the District Court put it, a pressure of a few thousandths of a micron in a DeForest audion".

This comes down to a mere difference in degree.

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[2] Rec., Vol. 3, p. 1426.

Difference in Degree Not Patentable.

This Court, in a long line of decisions, has consistently held that mere variations in degree are not patentable:

Munson v. *New York*, 24 U. S. 601;
Milligan & H. Glue Co. v. *Upton*, 97 U. S. 3, 6;
Pearce v. *Mulford*, 102 U. S. 112;
Guiduet v. *Brooklyn*, 105 U. S. 550, 552;
Slawson v. *Grand Street*, 107 U. S. 649;
Estey v. *Burdett*, 109 U. S. 633, 640;
Burt v. *Evory*, 133 U. S. 349;
French v. *Carter*, 137 U. S. 239;
Ansonia Brass & Copper Co. v. *Electrical Supply Co.*, 144 U. S. 19;
Belding Manufacturing Co. v. *Challenge Corn Planter Co.*, 152 U. S. 100.

The sole exception to this rule is where the change in degree produces some wholly unexpected result causing the device to function in an entirely different manner.

The rule and not the exception applies in the present case.

The early DeForest audion amplifiers clearly operated without any harmful ionization when used with voltages suitable to the degree of evacuation, and that is all that can be said of the tubes alleged to infringe. When DeForest exhibited the amplifier to the Western Electric Company in 1912, it amplified the weak voice currents with great fidelity, according to the testimony of Jewett and Colpitts, who were experts in the art.[3]

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[3] Rec., Vol. 1, p. 410, Q50; p. 497, Qs. 81, 82; p. 555, Q8.

Its perfect performance in amplifying the speech currents is proof positive that there was no harmful ionization. Actual use is the ultimate test on this point, from which there can be no appeal.

There is no question, therefore, that this prior art tube operated precisely as the patent says the patented tubes should operate, *i. e.*, by a grid-controlled space charge effect substantially unaffected by positive ionization. And no matter how far up along the scale of improved vacuum we go we cannot get any other kind of performance than that. The advantage of improving the vacuum lies not in getting a *new* kind of performance but in getting *more* of the same kind. That is, instead of getting this amplification with only a little electrical power, we can get it with a large power. *The patent itself, both in the specification and the claims, teaches that very thing* and speaks much more loudly than Respondent's counsel when they try to assert, without supporting evidence, that there is some sort of zero point or dead-line between the DeForest amplifier performance and that of more highly evacuated tubes. The specification of the patent, as we have already noted *supra* (p. 20), says that the degree of evacuation will be proportioned to the voltage it is desired to apply to the tube, and the claims describe the invention as including tubes performing at voltages all the way from 40 up to 200 or more. As shown above (p. 98) DeForest audion amplifiers were operated at voltages up to 50 and 60 volts. The patent claims might just as well have begun at 30 volts instead of 40. What Langmuir sought to do was to patent the use of vacuum tubes at any and all voltages above what he *then* knew was being used. Indeed, on January 29, 1917, Lang-

muir did add a claim numbered 25 directed to cover a tube deprived of sufficient gas to permit its use with 30 volts.[4] This claim was canceled July 30, 1925,[5] after he had apparently learned that audions had been used with 30 volts. He no doubt had no knowledge of the practice in California of using as high as 67½ volts or he would undoubtedly have canceled all claims for use of voltages below that amount.

In this connection, Respondent relies heavily upon an early statement or two of DeForest expressing the view that the operation of his audion was in some way affected by the residual gas. Well, DeForest was wrong (except to the extent that the detectors are even now considered somewhat better with a gas content). For a long time, it is likely, he did not altogether understand the scientific explanation of his own invention; and it was not required that he should. But that does not change the facts as now clearly established by the evidence. Respondent will admit that even Langmuir made some very serious mistakes in connection with the very patent application here involved, some of which we have already pointed out.

Since, then, the tubes now asserted to infringe operate like the old DeForest tubes except as to the amount of *power* some of them can handle, we think it clear that the patent, even considered in its most favorable light, is invalid as covering a mere difference in degree of vacuum.

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[4] Rec., Vol. 6, p. 736.
[5] Same, p. 764.

The Lack of Invention Over the Prior Art Disclosures as Evidenced by the Attitude of the Experts of the Telephone Company and the General Electric Company.

As to the question whether the tube of the patent in suit presents any *invention* in view of prior art, we find a most unusual situation, and one of very persuasive force. The thing which is *now* asserted to be a wonderful and important invention was separately produced in 1912 and 1913 by two eminent engineers working in this art for two large industrial companies—Arnold of the Western Electric Company and the American Telephone and Telegraph Company and Langmuir of the General Electric Company—*and neither one of them thought at the time that he had made any invention at all.* Langmuir claims to have produced a tube of the kind covered by the patent before the end of 1912. He did not file an application for patent until late in 1913, and *then even it did not occur to him to claim such a tube as his invention. He claimed merely a specific process for exhausting gases from the contained electrodes* (bombardment without heating). Arnold produced the same kind of tube in the Fall of 1912. Neither he nor those associated with him in the Western Electric Company and the Telephone Company thought of looking upon it as an invention, and no application for patent upon it would have ever been filed by Arnold, had it not been learned that the General Electric Company was attempting to patent such a tube in Langmuir's name. Arnold, convinced of his own priority, then filed an application so that if a patent was to issue at all it should issue to the *first* inventor as required by law.

As we shall see in discussing the question of priority, both Arnold and Langmuir produced tubes, like those now said to infringe this patent, by starting with DeForest audions and improving the vacuum sufficiently to carry the desired loads without gas ionization, and it is quite evident that it seemed to each of them that in so doing he had merely employed obvious engineering expedients. Under these circumstances, one cannot escape the feeling that the idea of claiming such a tube as an *invention* arose later, only when someone awoke to the possibility of controlling the vacuum tube and dependent industries by means of a patent therefor.

It is therefore submitted that the Langmuir patent is invalid because it is anticipated and discloses no patentable invention.

POINT II.

The majority opinion of the Court below sustained the patent on an untrue definition of the alleged invention.

Gas as a Conductor.

In the petition for rehearing in the Circuit Court of Appeals, Respondent told the Court that Langmuir's invention was a tube in which he substituted a vacuum for the "column of conducting gas" upon which the Fleming and DeForest vacuum tubes depended.[8]

This was a brand new definition of the invention. In presenting it to the Court below, Respondent definitely meant, we think, to assert that the Fleming and DeForest tubes actually *did* depend upon a gaseous conductor, not merely that it was popularly *supposed* that they did. If it meant the latter, it was, of course, crediting Langmuir, not with producing a new *thing*, but merely with furnishing the true explanation of an *existing* thing; and the whole argument falls at once. Patents are not granted for new explanations. It was necessary to Respondent's new theory that it assert positively, dependence upon a gaseous conductor by Fleming and DeForest, and we find that it does. For example, on page 21 of its brief, upon the rehearing, it is stated:

> "The principle of the DeForest audion was conduction by a column of gas."

The majority opinion accepted the definition of the invention thus advanced, saying in so many words[9] "the

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[8] Rec., Vol. 3, p. 2014.
[9] Rec., Vol. 3, p. 2028.

Langmuir tube is a tube in which for example the gaseous conductor incident to a Fleming valve and a DeForest audion is dispensed with and a vacuum substituted therefor", and upon the assumption that this was true, it found that Langmuir had made a patentable invention. Indeed, if we accept the definition, patentability follows almost as a matter of course, for to take an old combination and get the same or a better result by removing one of the elements is the very sort of thing generally accepted as involving invention. Such a simple and striking accomplishment might expect a ready allowance from the Patent Office.

But this definition is false, and with it must fall the entire theory upon which the Court found the patent valid. It is contradicted by the whole history of the Langmuir patent in the Patent Office and in this litigation, by undisputed scientific facts as to discharges in vacua, and *by the explicit testimony of Langmuir himself.*

The Fleming and DeForest vacuum tubes did *not* have a "conductor of gas", so that Langmuir could not have made an invention by taking it out. We shall show this in a moment out of Langmuir's own mouth, but first let us consider how incredible the assertion is upon its face.

Earlier Attempts to Define the Invention.

Note that this asserted substitution of a vacuum for an alleged "gas conductor" is not the invention that is claimed by the patent. The application for this patent was in the Patent Office twelve years. Most of that time was spent by counsel for Respondent in trying to show that there was *something* patentable in the case or trying to define the patentable thing to his own satisfaction and that of the Patent Office. The application was amended thirteen

different times, involving no less than eighty distinct changes in the specification besides innumerable changes in the claims, and a total of sixty-two different claims were submitted at different times in an effort to avoid the prior art and to define a patentable invention. The changes involved in the repeated re-writing of the description of the invention, bulk one and one-half times the original specification. *If the invention had been the simple, clear cut thing we are now told it is, Langmuir would not have begun in 1913 by claiming an inoperative process of gas-freeing electrodes, and ended up in 1925 with thirty-two claims to something defined by references to a 3/2 power law, logarithmic plots and flat-topped temperature curves.* He would have received his patent in short order, and it would have had two or three claims to an audion, or like tube, with a vacuum in place of the gas conductor. *No such claims were ever presented to the Patent Office.*

In the early days in the Patent Office the Examiner of Interferences stated

> "A controversy has arisen as to just what improvement over the prior art is in issue * * * *Langmuir contends* it is a correlation of the physical structure of the tube with relation to the degree of vacuity, resulting in a new device."[9b]

But even after the twelve years in the Patent Office, Respondent's troubles in trying to define the invention were not over. When it came to try and argue this case, both the Trial Judge and the Court of Appeals had great difficulty in ascertaining from the patent claims and the general

[9b] Interf. Rec., p. 2476.

discussion what the invention really was, and counsel for Respondent was urged time and again to define it clearly and simply. As late as the hearing on appeal, the following was the best he could do:

> "The Langmuir invention is a coordination of elements having a new functional relation between various factors, producing a new result. It is not a matter merely of maintaining a certain vacuum, far less of *producing* a certain vacuum which will be destroyed the moment the tube begins to operate. It involves primarily a relation between the shape, size and space relation or 'geometry' of the parts of the tube and the nature and pressure of the gas therein contained, coordinated and adjusted with respect to the conditions of the electric circuit."[28]

This rather appalling definition was written as late as 1928 and signed by the same attorney who prosecuted the Langmuir application before the Patent Office and who represented Respondent at the trial of this case.

To us it is past belief that, if the Langmuir invention really had consisted in removing a gas conductor upon which the DeForest tube depended, he would not have discovered that simple fact during his seventeen years' acquaintance with the case prior to 1930, when the new definition was first advanced.

Terminology as to Gas Conduction.

Respondent attempts to support its present assertion that the tubes of Fleming and DeForest depended upon a gaseous conductor (which Langmuir took out), mainly upon

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[28] Quoted by Judge Woolley (Rec., Vol. 3, p. 2060).

a loose terminology which grew up before anybody understood much about what went on in a hot cathode vacuum tube.

When Edison discovered in 1884 that a current would flow across a vacuum tube from a hot filament to a cold electrode, no one had ever heard of electrons. It was years thereafter before anyone could explain scientifically what happened in such a tube. They knew that there was some gas left in the tube (as there always must be), and that somehow the current got across the gap. Accepted electrical terminology as of that time, and indeed today, refers to anything that permits the passage of an electric current as a "conductor". Quite naturally, therefore, the attenuated residue of gas in vacuum tubes was referred to as a "gaseous conducting medium", and in the ordinary sense it is not at all an inaccurate name. It is *only* a name, however, *and in the sense just referred to applies just as accurately to the vacuum tube of the patent in suit as it does to the preceding vacuum tubes of Fleming, DeForest or Edison.* Everyone knows how terminology—right or wrong—persists once it is accepted and used for a while. For instance, we find that the Patent Office, as late as 1925 when the Langmuir patent issued, classified this very patent under the title "Detectors, *Gaseous Elements*".

It seems to us quite unjustifiable for Respondent to try to establish as a scientific fact that the Fleming and DeForest tubes depended upon "a conductor of gas" in a sense not applicable to later vacuum tubes, by quoting, as it did in the Court below, random cases where this terminology has been used in referring to the early tubes. In deciding the question whether the Fleming and DeForest tubes

did have an actual "conductor of gas" in the sense that it was something Langmuir "left out" of his tubes, the Court will doubtless rely, not upon the mere matter of terminology, but upon the positive evidence which this record contains as to whether there is in fact such a difference.

Langmuir's Testimony as to Gas Conduction.

Langmuir himself has definitely testified that the residual gas in such tubes as Fleming's and DeForest's, even when there was enough to cause ionization, was *not* a "conductor" of the current. His testimony on this point got into the record because Langmuir in his application for this patent, as first filed, made the mistake (as is now admitted) of saying that the gas, at least if ionized, did act as a conductor. His statement there was:

> "The positive ions [gas molecules] *take part* in the conduction of current, giving at first erratic readings on measuring instruments connected in circuit".[1]

And, in the following paragraph, he stated that the "audion", the DeForest tube, was a device taking advantage of that phenomenon. This statement by Langmuir was one of several blunders he made in his early work along this line. *He was careful to cancel it before the patent issued and he entirely repudiated any theory of gas conduction in his testimony.* He was examined[2] with respect to the above quoted statement in his patent application and was asked whether the sentence would be true if it read

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[1] Rec., Vol. 6, p. 663.
[2] Interf. Rec., p. 1775, XQ70.

"the positive ions take part in the conduction of current by *acting as conductors* or carriers of current." The answer he gave was:

> "In my opinion the sentence would have *no sensible meaning* if the word 'conductor' was left in *for it is inconceivable that ions could be conductors of current.* I will, therefore, confine myself to the case where the positive ions act as 'carriers.' With this correction I can say that *the statement would not have been true.*"

Note that Langmuir says that it is not "sensible" to use the word "conductors" as referring to the ionized molecules of the gas, because *"it is inconceivable that ions could be conductors of current."* Thus he emphatically rejects the use of the word "conductor" as applied to the gas in the sense of Respondent's belated definition. And he goes on to say that even construing the word conductor to mean carrier, still the statement is not true.

With Respondent's own witness Langmuir, the patentee himself, thus positively denying that the gas content, even when ionized, is a conductor of the current in a vacuum tube, we do not see how Respondent can be heard to assert the contrary. This seems to us itself entirely to dispose of Respondent's eleventh hour definition of the invention upon which it apparently now stakes its whole case.

The Prior Art on Conduction of Electricity by Gas.

Such being the fact about the gas content, it would make little difference whether Fleming and DeForest or those familiar with their vacuum tubes, *thought* that the residual gas was the conductor. Their theory as to that would be a

mere theory as to the method of operation. As already mentioned, the patent law does not require an inventor to understand the scientific explanation as to how his device operates, nor does it provide for the granting of a patent merely for discovering the true method of operation of a known device.

There is no testimony in the record that either Fleming or DeForest ever purposely left a definite residue of gas in their tubes for the purpose of conducting the current or of making them operate. On the contrary, there is very definite evidence in the record that both Fleming and DeForest sought to obtain the best vacuum attainable with the exhausting apparatus available for commercial purposes. In Fleming's patent[3] it is stated:

> "As a *very high vacuum* should be obtained in the bulb (a) and as a considerable quantity of air is occluded in the conductors, these should be heated when the bulb is being exhausted" (p. 158, line 96).

In an article by Fleming[4] he states:

> "An ideal and perfect rectifier for electric oscillations may, therefore, be found by enclosing a hot carbon filament and a perfectly cold anode *in a very perfect vacuum.*"

In his article in the Scientific American Supplement of January, 1906, Fleming says that

> "a high vacuum may be a very good conductor provided that the negative electrode is rendered incandescent. This shows that the obstruction which a high vacuum offers to the passage of electricity is

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[3] Deft.'s Ex. 15, Rec., Vol. 6, p. 157.
[4] Deft.'s Ex. 14, Rec., Vol. 5, p. 144.

> not due to the mere reduction of the matter in the space (that is, to the rarifaction of the gas), but is in some way or other, largely dependent upon the temperature of the electrodes; the resistance to the passage of electricity through a vacuum can be rendered very small by intensely heating the negative electrode."[5]

In this same paper he says that by certain experiments he is able to show that the highest vacuum producible may be "a very good conductor", and describing the experiments in question he says:

> "Let this bulb be exhausted as completely as possible, so that in it the highest obtainable vacuum is made. To achieve this, the filaments must be heated to bright incandescence while the exhaustion is going on."

This aptly illustrates the point we made above about the meaning of the word "conductor" as hitherto applied to a vacuum, and illustrates as well how insistent Fleming was upon the highest vacuum obtainable even when he referred to the residual gas as a "conductor".

Certainly Fleming was not intending to leave any gas in the tube in order that he might use it to "conduct" the current, as Respondent would have us believe.

The testimony of Waterman given in a suit by the Marconi Company against the DeForest Company and stipulated into this case[6] fully confirms these facts about the Fleming tube. He said (p. 1487):

> "I think I forgot to say yesterday that the action which Fleming was talking about was one which

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[5] Rec., Vol. V, pp. 167, 168, 169.
[6] Rec., Vol. 3, pp. 1485 *et seq.*

would take place to best advantage in a *perfect vacuum*, any space containing *no gas whatever*, because the electrons which Fleming referred to are derived from the filament."

And, again (p. 1488):

"The action is, as Fleming stated, purely electronic, an action which gives us conductivity as the result of electrons emitted from the filament, and not as the result of any matter contained in the space surrounding the filament."

And, again (p. 1488):

"But one thing is very conclusively established, and that is that the action which takes place is an electron action just as Fleming said it was, and as most of the writers agree with this, and that is shown by the fact that the same action takes place exactly if we make bulbs which have what is now called the absolute vacuum which means a vacuum so high that no known test will reveal any attribute of gas."

There is similar evidence that DeForest did not depend upon gas as a conductor and did not intentionally leave it in the tubes (although he may have purposely selected the more poorly exhausted tubes for "detectors" for reasons already indicated). In 1912 DeForest, then with the Federal Telegraph Company in California, wrote to the McCandless Company in New York, the manufacturer of his audion tubes, saying:

"Out of the last lot of 24 audion bulbs which you manufactured for us there are only 4 that came up to proper sensitiveness test. *Apparently the vacuum in the other bulbs is too low,* because in these latter

bulbs we notice that the blue arc or cathode beam starts suddenly at 15 or 20 volts, under which condition the bulb is not sensitive"[7]

And the following month he wrote:

"We took two of the poorest of the discarded 20 to a San Francisco glass-blower, unknown to fame, *and had him exhaust same to as high a vacuum as his pumps would take.* These reexhausted bulbs now show a sensitiveness equal to those of the first four, *which proves conclusively that our contention is correct.*"

Respondent's own witness Hogan testified concerning the DeForest tubes in a suit brought by Hewitt against the American Telephone and Telegraph Company, and he reaffirmed and adopted that testimony in this record.[7a] The Telephone Company was using high vacuum tubes corresponding entirely to those asserted here to infringe. Hogan having testified that he was familiar with the DeForest tubes, was asked to state how they "differed from the Telephone Company's tubes". He answered (p. 119) that the "Telephone Company's devices were much more highly evacuated than are most audions", and continued (p. 120):

"In regard to the relation of defendant's vacuum tubes and the audions of DeForest, I believe that the residual gases must play some part in the operation of both and that the magnitude of the part played in either will be determined by the particular design, voltage and exhaustion used, and that there is no strict line of demarcation between them.

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[7] Deft.'s Ex. 79A, Rec., Vol. 6, p. 1061.
[7a] Rec., Vol. 1, pp. 101-118.

> "Tubes made by the defendant's company amplify, and audion tubes made by DeForest amplify, and I do not think that you can set one of them on one side of the fence and say, 'They are audions' and the others on the other side of the fence and say 'they are defendant's vacuum tubes which are quite different things.'"

In the *Marconi-DeForest* case above referred to,[8] Judge MAYER had to decide, among other things, whether the DeForest tube contained gas which affected its characteristic operation. His conclusion was:

> "If anything was shown in this record, it was rather, as plaintiff contends, that the device [DeForest's tube] operates in spite of, and not because of, ionization by impact."

In support of its new definition of Langmuir's invention, Respondent attempted below to create the impression that Langmuir was indeed the first one to discover that a current could be made to flow in an extremely high vacuum, without dependence upon a gaseous medium. The testimony in the case shows that this is far from the fact. Langmuir himself testified:

> "Lilienfeld proved beyond question, I think, that he obtained discharges, in some cases at least, in which the effects that he measured were not dependent upon gas ionization.[9]
>
> "Lilienfeld probably succeeded in obtaining a discharge in high vacuum substantially free from effects

[8] 236 Fed. 942, 954.
[9] Interf. Rec., p. 1378.

of positive ionization in the device he described in his 1910 papers."[1]

Lord Kelvin in 1904 made a very careful statement summarizing the scientific facts as of that day in the following language:

> "The labors of many experimenters during the last fifty years, and the comparatively modern atomic theory of electricity, have thoroughly confirmed the view that the space of our best modern vacua, interstellar and interplanetary space, and generally, space occupied only by the luminiferous aether is a very perfect non-resister of electricity passing through it".[2]

Von Baeyer, who takes high rank in the scientific world (Interf. Rec., p. 868), stated in 1909, referring to his own work with electric currents through vacuum tubes:

> "These experiments were of course carried out in the highest possible vacuum to avoid the influence of ionization".[3]

In support of its new definition of the Langmuir invention, Respondent's counsel also referred to an advertising circular of the DeForest Company, put out in 1919. They refer to this to prove that DeForest tubes were inoperative where the vacuum became too good, thus indicating that they depended upon a "conductor of gas"; and the majority opinion below apparently leaned rather heavily upon

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[1] Interf. Rec., p. 1521.
[2] Rec., Vol. 5, p. 171.
[3] Rec., Vol. 5, p. 284.

this circular, referring to it as showing "that gas was an element of operation" in the DeForest tube.

The circular was not put in evidence for such purposes, and does not prove the point. It was put in by Respondent through the testimony of Mr. Hogan, being one of a number of circulars, catalogues, etc., used by him to show sale by the DeForest Company of various types of tubes.[4] *Hogan did not testify that these tubes required a "conductor of gas" or that it was a necessary element in their operation.* He testified, quite to the contrary, that the DeForest tube and the so-called high vacuum tube were the same in principle, as shown by the above quotations from his testimony (p. 51). No one from the DeForest Company responsible for the circular was put on to testify or be cross examined as to the statements contained in it. It has no more standing here than any other trade circular manifestly put out to promote the sale of goods. It is obviously designed to impress prospective purchasers with the idea that the new tubes are much better than the old. It does *not* say that the old tubes depended upon a "conductor of gas". Its reference to former tubes becoming inoperative when they became too "hard" (high in vacuum), can refer only to "detector" tubes of which it is measurably true for reasons indicated above. It could not apply to amplifier or other tubes because the very next sentence of the circular says that the tubes whose sale it is boosting are "purely electronic", "exhausted to a very high vacuum", which, by the same sign, would make *them* inoperative.

Indeed, it appears to us rather fantastic for Respondent to say, as in effect it does, that if the vacuum in a DeForest tube was made better by him or became better in use, the

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[4] Rec., Vol. 3, pp. 1623-1633.

tube was no longer operative, but that if it was made better by Langmuir, the usefulness was greatly increased.

It is apparent therefore that the theory and definition of the Langmuir invention upon which the decision of the Court of Appeals is based is not only unsupported by any evidence in the record, but is flatly contradicted thereby and expressly repudiated by Langmuir himself. The judgment of the Court should therefore be reversed on this ground alone, if for no other.

POINT III.

If the subject matter of the patent in suit involves patentable invention, then Dr. Arnold was the first inventor thereof and not Dr. Langmuir, the patentee.

Judicial Consideration Given Heretofore to this Question.

This defense was sustained by the District Court and by Judge Wooley, and is not referred to in the majority opinion of the Court of Appeals.

The alleged invention of the patent in suit was anticipated by the work of Dr. H. D. Arnold of the Telephone Company, who prior to Langmuir, produced vacuum tube amplifiers which were unquestionably of the kind now asserted to infringe, and therefore the patent is void. This was one of the main defenses presented at the trial of this case, in which more than three weeks were devoted to testimony on this one point. Although this defense was separately considered and sustained by the Trial Court, the majority opinion of the Court of Appeals entirely ignores it.

This question of priority between Arnold and Langmuir was the subject of an Interference in the Patent Office, and is still pending in a proceeding under Sec. 4915 R. S. in the Southern District of New York.[1]

The patent in suit was issued to Langmuir as the result of an award of priority to him in the interference, by the Court of Appeals of the District of Columbia. That decision reversed the decision of the Commissioner of Patents who had awarded priority to Dr. Arnold. The opinion of the District of Columbia court covers less than four pages including quoted claims,[4] and itself gives no reasons at all why the award should go to Langmuir. After very briefly

[1] As this present suit was brought on for trial before the proceeding under Section 4915 R. S. could be heard, and as the Petitioner here had pleaded in this suit that Arnold was the prior inventor of the alleged invention of the patent and thus the issue of priority between Arnold and Langmuir would be tried and passed upon in this case, the American Telephone & Telegraph Company, which owns the Arnold application, offered to assist the Petitioner in the presentation of the priority issues before the District Court. This offer was accepted by Petitioner and the priority issue was very largely handled by counsel for the Telephone Company in both the District Court and the Circuit Court of Appeals, as it is being in this Court (Rec., Vol. 1, p. 399). Meanwhile the case under Sec. 4915 has not yet been tried. Of course, if the priority issue had been inadequately presented by lack of evidence or otherwise in this proceeding, there might have been a decision adverse to Arnold. Such a decision, coupled with that of the Court of Appeals of the District of Columbia, would have made it difficult for the Telephone Company to succeed in the suit brought under Section 4915 R. S. It was therefore advisable for that Company for its own protection to assist in this suit.

[4] Rec., Vol. 4, pp. 41-44.

relating the history of the case, it merely accepts without comment, the decisions of "the lower tribunals" (the Examiner of Interferences and the Board of Examiners-in-Chief) who had found for Langmuir, because, as the court put it, those decisions "are so clear and satisfying" that it was content to rest its opinion "upon the reasoning there given", apparently quite overlooking the fact that these lower tribunals were poles apart in their "reasoning" and in their rulings as to the effect to be given to the different steps in the work by Arnold and Langmuir respectively. For example, the Board found that Langmuir conceived the invention in August and reduced it to practice in November, 1912, while the Examiner of Interferences held that neither his August work nor his November work showed even a conception of the invention, but found that he conceived and reduced to practice in April, 1913. As to Arnold, the Examiner of Interferences refused to hold his disclosure of November 1st, 1912 effective to prove conception of the invention because of an odd theory he indulged that, as to this particular invention, conception and reduction to practice must have been simultaneous, while the Board held the disclosure sufficient except for the fact that they were not sure that Arnold knew how to get the vacuum he proposed to use in the audion.

These holdings of the "lower tribunals" were not only divergent (as stated above), but were in the main erroneous both in law and in fact on the evidence presented at the trial of the case, as we shall point out below (pp. 63 *et seq.*).

At the trial of the case before Judge Mohun, a very large amount of testimony as to Arnold's priority was introduced which was not before the Patent Office and the Court of Appeals of the District of Columbia. It covered

important points in the case for Arnold upon which one or more of the Patent Office tribunals had expressed doubt, as for example, whether Arnold did in fact know how to get the desired vacuum at the time of his conception of the improved tube in November, 1912. Altogether, the Petitioner examined eight witnesses and the Respondent six witnesses on this question of priority, and their testimony comprises a large portion of the printed record. It is in addition to the testimony taken in the Patent Office Interference, which was also introduced in evidence in this case.

In connection with this branch of the case we believe that the decision of the Commissioner of Patents in the Interference proceeding, which is remarkable for its clarity, and the decision of Judge Morris upon priority, rendered as it was in the light of the additional proofs, will be of material assistance to this Court, and we commend them to its consideration. These decisions will be found printed in separate pamphlets for the court's convenience. The decision of the Commissioner is also found in the Interference Record, the part we particularly refer to beginning at page 2514, and Judge Morris' opinion will also be found in Vol. 3 of this record, pages 1966 to 1969.

The Supposed Invention Involved in the Priority Issue.

It is usually difficult to decide priority of invention without knowing quite definitely what the invention is; and when we say "invention" we mean the thing as to which priority is in dispute, without implying anything as to its patentable quality.

In the present case, as we have seen, Respondent itself has never been able to state clearly and briefly what the

supposed invention is. However, from the evidence we shall consider below, it will be quite clear that whether it be as stated in the eleventh hour definition presented by Respondent at the rehearing, or what the Commissioner of Patents said he would assume it to be for the purposes of deciding priority, or however it be defined, *Arnold was the first to produce it.* The Commissioner of Patents evidently doubting the presence of invention at all but, under the Patent Office practice, assuming invention for the purposes of deciding priority, expressed it as follows:

> "It will be seen that the present invention lies not in discovering or producing something new, but in perceiving the practicability of scientific facts known in the laboratory, and in making practical, useful devices embodying the scientific laws known in the laboratory".[a]

When we come to the evidence in the case it will indeed become clear that what both Arnold and Langmuir *actually contributed* in this connection, was precisely the suggestion that the usefulness of the DeForest audion be extended by the application of certain known facts concerning thermionic discharges in vacua.

The simple fact is that, under *any* definition, an old DeForest audion pumped a little cleaner, especially as to the walls and electrodes, is a tube of the Langmuir patent; no other change is necessary. There is no dispute about this,—it is admitted by the Respondent.[b]

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[a] It is interesting to note that even *this* is not patentable to the newcomer in the field (*Corona Cord Tire Co.* v. *Dovan Chemical Corp.*, 276 U. S. 358).

[b] See page 35, *ante*.

Arnold's Work.

Conception and Disclosure of the Invention by Arnold.

The evidence shows that Arnold was sought out and employed by the Western Electric Company officials in 1911 because of the extensive training and experience he had had in the field of electrical discharges in vacuum,[6] and for the express purpose of designing a repeater [a] for telephonic purposes. The Telephone Company had shortly before committed itself to the furnishing of transcontinental telephone service by the time the San Francisco Exposition was supposed to open in 1914, and its engineers knew that this would require the production of a telephone repeater quite different from anything then in sight, and probably employing some form of vacuum or gaseous discharge.[7]

President Vail of the Telephone Company had placed Dr. Frank B. Jewett in charge of the technical development work for this projected New York-San Francisco telephone line. Dr. Jewett was then Assistant Chief Engineer of the Western Electric Company in charge of its research and development work, the Western Electric Company being

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[6] Rec., Vol. 1, pp. 404 *et seq.*

[a] The farther the speech modified electric currents go on their way from the transmitter at one end to the receiver at the other end in a long distance telephone conversation, the weaker they get. A "repeater" is a device interposed in a long telephone line which receives the weak telephone currents on the input side and sends out corresponding strong currents on the output side. In present day practice there may be a score or more of such repeaters at regular intervals in a telephone line extending as far as from New York to San Francisco.

[7] Rec., Vol. 1, pp. 402-404.

the manufacturing subsidiary of the Telephone Company. Under Dr. Jewett was Dr. E. H. Colpitts, directly in charge of the Research Laboratory of the Western Electric Company. In more recent years this laboratory has been separately organized as the "Bell Telephone Laboratories, Inc." Both Dr. Jewett and Dr. Colpitts were highly proficient as telephone engineers, and as theoretical and practical physicists.[7a] Under Dr. Colpitts was Dr. Arnold.

For nearly two years prior to his conception of the present invention, Dr. Arnold had been working upon this telephone repeater problem for his employer and had about perfected a very satisfactory, though comparatively complex repeater element of the vacuum type using mercury vapor.[8] On November 1, 1912, he first saw a DeForest audion set up as an amplifier. DeForest himself had brought the apparatus to the Western Electric Company two days earlier and demonstrated it to Dr. Jewett and Dr. Colpitts, officials of that Company, in the hope of selling rights under his patents to the Company. Both Dr. Jewett and Dr. Colpitts were electrical engineers of high standing and long experience, and were quite capable of appreciating the virtues and defects of the audion, but they did not know what the defects were due to or how to remedy them. For the purpose of appraising the possibilities of the audion they turned to Dr. Arnold because of his specialized training in this field.

On November 1 Arnold was called in, and in company with Colpitts and Jewett, he examined and tested the audion

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[7a] See Rec., Vol. I, pp. 396 *et seq.* and 482 *et seq.*

[8] Rec., Vol. 1, p. 495, Qs. 64, 65.

amplifier as an amplifier of speech currents. All three were impressed with its remarkable performance on weak speech currents.[9] All saw its defects when larger currents were applied; it would then choke or distort the speech, sometimes showing a blue haze in the discharge space. To all three it was clear that these limitations made it unsuitable for telephone work, as it then stood.[1]

Then and there Arnold saw the cause of the trouble and named the cure. He said they would make the vacuum better and so eliminate these erratic ionization effects at the heavier currents.[2] He made other suggestions as to better filaments and better mechanical structure but these have nothing in particular to do with the patent in suit. When, however, Arnold said to make a telephone repeater by taking the physical structure of the audion and improving the vacuum so as to eliminate the ionization, he had in mind, and disclosed to his associates, a complete conception of the invention,—it was this idea to which we referred above, of accomplishing a definite, useful purpose by the application of principles then known to him, governing thermionic discharges in vacua. A DeForest audion more completely evacuated is, as above noted, admittedly a tube within the Langmuir patent.

It is highly significant that within a few days Dr. Arnold also made a thorough disclosure to Dr. Colpitts of the fundamental operating principles of the audion when

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[9] Rec., Vol. 1, p. 410, Q50; p. 497, Qs. 81-82; p. 555, Q8.

[1] Rec., Vol. 1, p. 417, Q83; p. 500, Qs. 99, 104, 105; p. 599, Q11.

[2] Rec., Vol. 1, p. 559, Arnold, Q11; p. 501, Colpitts, Qs. 107-113; p. 413, Jewett, Q67.

it operated with a substantially perfect vacuum. It came about in this way. Colpitts questioned whether the electrons would be emitted from the hot filament if the vacuum were substantially perfect, that is he questioned whether some gas might not be necessary for the emission of the electrons. Arnold informed him that this question had been faced and settled by the scientific world, and that electrons undoubtedly would be emitted from the hot cathode in the absence of gas. Colpitts went on and questioned further why the electrons, if emitted, would not all easily rush across the space when only a volt or so of positive potential was applied to the plate; thus keeping the power output of the tube too low to be useful. In other words, if the electrons were emitted so easily why should any considerable voltage be necessary merely to move them across the empty space from the hot cathode to the cold anode? In reply to this question Arnold explained to him the space charge effect, the mutual repulsion between the electrons by which those ahead in the stream tended to push those behind back into the hot cathode, whence they had issued. To overcome this space charge effect a substantial voltage must be applied.[24] According to Langmuir this space charge effect is the fundamental principle of the invention.[25]

The Examiners-in-Chief in the Patent Office recognized Arnold's disclosure to Jewett and Colpitts as a complete disclosure of the invention, but refused to give Arnold the benefit of it for proof of conception, because they were not they said, convinced he knew how to get the necessary

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[24] Rec., Vol. I, p. 503, Qs. 115a to 124, p. 415, Q71.
[25] Interf. Rec., p. 1936, line 7 from bottom.

vacuum.[3] Here they were wrong both on the law and the facts. There is no rule of law that requires an inventor to have in *himself* the knowledge and skill to physically produce his conceived invention. The physical construction may, and frequently will, require a technique known to comparatively few; but obviously the inventor's conception is completed when his *idea of the thing to be constructed* is complete and he knows its useful application to the arts. Any other rule would be absurd. Was the DeForest audion patent, one of the greatest and most useful inventions of all time, invalid because, forsooth, DeForest was not a glass blower and so not himself possessed of the skill or knowledge necessary to construct the thing?

If the inventor also devised a new method of manufacturing the device, that would be another and separate invention.

The Commissioner noted and disposed of the Board's error as follows:[4]

> "If I say a rubber button is a good thing to use in a hose supporter, I have conceived the button, even if I do not know how to make such a button. I may go to a rubber manufacturer and have him reduce my invention to practice and it will be my invention. So here, one skilled in the art could produce the device in issue as soon as told to do so by Arnold";

and he cites, *McCormick Harvesting Machine Co. v. Minneapolis Harvester Works*, 42 Fed. 152-155, where it was said:

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[3] Interf. Rec., p. 2506.
[4] Interf. Rec., p. 2519.

> "He who first conceives and gives expression to the idea of an invention in such clear and intelligent manner that a person skilled in the business could construct the thing, is entitled to a patent provided he uses reasonable diligence in perfecting it".

However, the fact is that in *this* case, Arnold *did* know how to get the necessary vacuum. This was proved, beyond any doubt, by the new evidence taken in the Trial Court to supply what the Board thought was lacking.

Getting the necessary vacuum for the patented tubes, admittedly involves nothing in addition to the use of the usual pumping equipment, except expulsion of the occluded gases by some form of heat treatment of the walls and electrodes. The patent itself suggests nothing else.

Dr. Millikan, one of the greatest of living physicists, testified most positively and in detail that he taught Arnold to heat tubes under evacuation in an oven and to heat the electrodes by bombardment, for this purpose, while Arnold was at the University of Chicago from 1907 to 1910, inclusive. This was done in connection with a pumping system using liquid air, usually charcoal and liquid air, so that the very highest vacua could be obtained.[5] The process then taught Arnold would have been entirely sufficient to exhaust audions so that they would operate at 100 or 200 volts or higher without harmful ionization.[6] As we have already seen, the prior literature told of baking and bombardment during evacuation and Millikan taught Arnold these matters from the literature as well as by actual direction of

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[5] Rec., Vol. 1, p. 442, Qs. 9, 10.

[6] Rec., Vol. 1, p. 448, Qs. 20, 21, 22; p. 457, Qs. 38, 39, 40.

his work.[7] Moreover, Arnold had himself been practicing baking and electrode bombardment in the evacuation of his mercury vapor repeaters at the Western Electric Company Laboratories, for over a year, prior to November 1, 1912.[8] That problem of evacuation was quite as difficult as the evacuation of a high vacuum audion, because, while he purposely retained mercury vapor, *all* other gases had to be removed, not only from the space but from the walls and the electrodes.[9]

So when Arnold said he could make a good telephone repeater out of the DeForest audion by so improving the vacuum as to get rid of the gas which caused the ionization effects he and Jewett and Colpitts had observed at the higher current values, there can be no question,—on any theory,—that he had a complete conception of the thing in issue.

And this disclosure by Arnold, be it observed, does not stand on his testimony alone, but is vouched for by both Jewett and Colpitts, to whom it was made,—men of the highest professional standing and personal character. Moreover, connected as it was with the trans-continental telephone project, and with their first experience with that marvelous instrument, the audion, it is a thing they would never forget. The disclosure is furthermore confirmed by the contemporaneous written records of the 7-A audion and the derivation of the 3/2 power law by Arnold, and by the whole course of conduct of the Telephone Company thereafter.

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[7] Rec., Vol. 1, p. 458, Q41.

[8] Rec., Vol. 2, p. 746, RDQ723; Vol. 1, p. 584, Qs. 33-34; p. 490, Qs. 45 to 56.

[9] Rec., Vol. 1, p. 572, Q21; p. 583, Q31.

Events After Arnold's Disclosure of the Invention.

The disclosure of this conception by Arnold so convinced and impressed his superiors Colpitts and Jewett, that he was at once given the job of carrying it into effect, together with the other improvements,—in filaments, etc., necessary to make a commercially practical telephone repeater;—likewise, the job of fitting it to the telephone plant, which, in itself, was a task of some magnitude.[2]

Immediately after November 1, 1912, the character of Arnold's responsibilities was changed. Instead of working at the laboratory bench, he was put at a desk and given supervision of the work of others. A number of assistants were assigned to him—some especially employed for the purpose.[3] Negotiations and patent investigations were started with a view to acquiring rights under the DeForest patents which would enable the Telephone Company to put audion repeaters into the plant.[4]

All these things show that Arnold's suggestion for improvement of the audion was not a mere passing remark falling unnoted in the course of routine business, but on the contrary, *marked a turning point in the affairs of the department working upon repeaters*,—and for the reason that it convinced those in charge that the audion, then unsuitable for telephone use, could indeed be made practical for that purpose in the way outlined by Arnold.

Work upon this project was begun at once by Arnold and his assistants, and continued without interruption up

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[2] Rec., Vol. 1, p. 418, Qs. 86 to 91; p. 508, Qs. 138, 145, 146; p. 595, Qs. 51, 52.

[3] Rec., Vol. 1, p. 508, Qs. 139, 140; p. 594, Qs. 49, 50.

[4] Rec., Vol. 1, p. 422, Qs. 92 to 95.

to the following October when the high vacuum repeaters began to go into commercial use in the telephone system,—the license from DeForest having been secured near the end of the preceding July.

In considering this work, it should be remembered that what Arnold set out to make was a practical telephone repeater, not merely a tube embodying the supposed invention here in issue. There is a big difference. It would have been very easy for him with his then knowledge and experience, to have taken an audion and improved its vacuum so that it would have embodied every claim in the Langmuir patent, and still it would have been far from ready for telephone repeater use; and, moreover, it would have taught him nothing, and advanced his work not at all. The tube needed also to have its electron emission improved and its filament life lengthened and its internal impedance made right and its mechanical structure improved before it could go into the telephone plant. So what Arnold worked toward was a *practical, commercially useful* embodiment of this high vacuum idea for a very definite purpose, not merely a laboratory demonstration of it.

During November and December, 1912, Arnold had extensive tests made on audions to determine their operating characteristics and efficiency. He made plots of his data, and one of these[5] shows the relation between current and voltage by an exponent of 1.59—rather close to the theoretical exponent 1.5 of the 3/2 power law which the patent says characterizes the invention in issue. Also he worked out mathematically the theoretical 3/2 power law covering this relation, late in December—some weeks prior to the time it was first deduced by Langmuir.[6]

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[5] Sketch E. S. 87498 in Deft.'s Ex. 245.

[6] Rec., Vol. 1, p. 506, Qs. 126 to 134; Vol. 2, p. 1186.

In December, 1912, Arnold made a mathematical study of "Efficiency of the Audion", which was recorded by his assistant Pierce. More particularly, this was a precise ascertainment of the law of the marvelous "grid" effect by which slight variations of voltage in the grid circuit produce corresponding, but much larger, variations of current in the plate circuit. It was the *first calculation ever made by anybody of how an audion works.* This study was premised definitely on the assumption of high vacuum. When the theoretical part of the study was completed, Arnold directed Pierce to make comparison with an actual case of amplification of voice currents. This was done with Audion 7-A and the agreement was remarkably close.[6a]

This piece of work shows Arnold's penetrating understanding of the principles of the high vacuum audion and is one of the many items of his activity falling between his conception of the invention and its introduction into commercial use.

A new Gaede molecular pump was ordered by cable from Germany at his request in January, 1913, after he had failed to locate one in this country. From January to April, one of his assistants, Trimble, was working on the mechanical construction of tubes, experimenting with tantalum filaments,[7] and another assistant Nicholson, was working upon the Wehnelt oxide coated filaments,[8] which eventually were adopted. Also, during this time Arnold visited Princeton where a Gaede molecular pump was in use, and took measurements so that the proper base and driving mechanism might be ready when their own pump

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[6a] Deft.'s Ex. 247, formerly Arnold Priority Ex. 10; Interf. Rec., pp. 2185 *et seq.*; Deft.'s Ex. 244, former Arnold Priority Ex. 7, p. 41 bottom.

[7] Rec., Vol. 2, p. 661, XQ323; p. 748, RDQ26.

[8] Rec., Vol. 1, p. 614, Q91.

arrived.[9] Also a new type of instrument for measuring vacuum was designed and constructed,—one which would not introduce mercury vapor.[1]

When the new pump came in April, 1913, it was tested for performance by using it to evacuate several tubes upon which they had been or were then experimenting.[2] It was found to give good results. On it they produced vacuum tubes capable of carrying high voltages without ionization effects, as we point out below.

Nicholson's work on the oxide coated filaments was interrupted for a month or so, beginning about the first of March, by his assignment to work with some German inventors, who had come over to demonstrate the Von Lieben-Reisz-Strauss tube as a repeater. Thereafter, his work on audion filaments was resumed and continued on through the summer.[3] The license from DeForest was secured in July, after considerable delay due to involved title and other complications.[4] The same month, the manufacture of tubes intended to go into actual telephone use was commenced.[5]

Arnold was ill and away during August and September and Kendall was assigned by Colpitts, about the middle of August, to make up and install a repeater (amplifier) set in the toll lines at Philadelphia,—this work to begin as soon as Kendall returned from his vacation about September 1,

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[9] Rec., Vol. 1, p. 609, bottom.
[1] Rec., Vol. 1, p. 609, middle.
[2] Rec., Vol. 2, p. 755, RDQ734; Interf. Rec., Arnold, p. 50.
[3] Interf. Rec., Nicholson, pp. 2251-2; Trimble, p. 2248.
[4] Rec., Vol. 1, p. 422.
[5] Interf. Rec., Arnold, p. 53—top; Trimble, p. 2248—middle.

1913. Experiments with the improved audion repeaters in the toll lines between New York and Washington were begun at Philadelphia, September 5, 1913,[6] and a field trial under commercial service conditions was begun October 18, 1913.[7] Such repeaters have been in continuous and increasing use ever since. The following summer they were put into the new trans-continental telephone line.

During this period from November, 1912, to October, 1913, while the DeForest audion was being converted into a condition suitable for a commercial telephone repeater, there were at least three occasions, probably more, when there was an actual reduction to practice of the high vacuum improvement here in issue. Once in November when a "clean-up" of the residual gas was effected in one of the DeForest tubes ("7-A Audion"); again in April and May, 1913, during the try-out of the new Gaede pump when a number of the audions evacuated showed good vacuum and no ionization effects under high voltage tests; and again in September and October, in tubes built for and used in commercial service at Philadelphia.

It really makes no difference at all which of these dates is considered Arnold's date of reduction to practice, for he was abundantly diligent at all times from November 1, 1912, on; so that under the familiar rule,[8] his effective date of invention, in any case, becomes November 1, 1912, when the improvement was conceived.

We refer briefly to each of these occasions.

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[6] Interf. Rec., Kendall, p. 2257, middle.

[7] Interf. Rec., Kendall, p. 2259.

[8] The first to conceive is the first inventor, if he proceeds thereafter with due diligence to a reduction to practice. This rule is recognized by Respondent itself (p. 215 of its brief before the District Court).

November, 1912—Audion 7A.

Audion 7A was a reduction to practice of Arnold's conception of November 1, 1912, and occurred the same month. This was one of the original DeForest Audions (No. 7) in which the vacuum was improved by certain experiments which Arnold had performed upon it.[4] During these experiments the impressed voltage, in a long series of runs, was forced higher and higher, and eventually one of its two filaments was burned out (after which it was called 7A). From these things there resulted a "clean-up"[5] of gas within the tube like that well known in electric lamps from the burning of the filament[6] and akin to that referred to by Langmuir in connection with his own experiments of November, 1912.[7] It is true that in this work, Arnold was primarily interested in discovering the characteristics of the tube when operating with a pure electron discharge and the "clean-up" was in a way incidental.[8] But this makes no difference. Assume that it was wholly *accidental*. The only important facts are that a proper vacuum was attained and that *Arnold recognized its presence and effect*.[9] On this point the testimony is quite clear. Arnold knew that the clean-up was going on; knew why it was going on and knew that it was giving him freedom from ionization effects at higher and higher voltages.[10]

Audion 7A, after the clean-up, was in fact so clear an embodiment of the supposed invention that there can be no

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[4] Rec., Vol. 1, p. 602, Q59.

[5] Rec., Vol. 2, p. 1140.

[6] Rec., Vol. 2, p. 758, Q743.

[7] Robinson on Patents, Vol. 1, Sec. 83, p. 126, and Sec. 79, p. 121 and cases quoted this brief, pp. 61 *et seq.*

[8] Rec., Vol. 1, p. 596, Q52; Vol. 2, p. 763, end of Q747; p. 758, end of Q743; p. 736, XQs. 680, 688.

real question on the point. It stood plate voltages up to 80 volts without any evidence of ionization.[5] The patent claims cover anything down to 40 volts. Compared with a General Electric tube of 1919, it gave almost the same logarithmic plot up to 81 volts on the plate, with a plate current of 3 milliamperes.[6] The fact that so clear an embodiment of the subject matter of the patent could be obtained so simply from one of the prior DeForest audions does not alter the fact that this was plainly a reduction to practice of the thing covered now by the patent in suit, and establishes Arnold's priority as against Langmuir.

The April and May Tubes.

Even the lower Patent Office tribunals which decided against Arnold, found that tubes made under his direction in April and May, 1913, were embodiments of the improvement in issue. The Examiner of Interferences and the Examiners-in-Chief, both gave him a reduction to practice as of this period.

These tubes were evacuated on the new Gaede molecular pump which is the one suggested by the patent in suit.[7] During evacuation they were thoroughly heat treated to remove all occluded gases, the glass by baking, the filaments by glowing, and the other electrodes by bombardment under voltage up to 300 volts which is higher than would be applied in use.[8] *These are precisely the precautions and the*

[5] Interf. Rec., p. 2183, top; Rec., Vol. 1, p. 603, Q63.

[6] Deft.'s Ex. 246—Interf. Priority Ex. 9, Interf. Rec., p. 2183, bottom; Rec., Vol. 1, p. 602, Q60.

[7] One of them was made earlier on the Gaede mercury pump but tested in April.

[8] Interf. Rec., pp. 2276 to 2278, 2247, 2191; Rec., Vol. 1, p. 618, Q98.

only precautions taught by the Langmuir patent application.

The testimony, fully supported by contemporary written records, shows that when one of these tubes, audion 20.2, was tested *as a voice amplifier, it multiplied the power 26 times, with 69 volts in the plate circuit.*[9] The witnesses say the quality was good on that occasion,[1] and there is no evidence to the contrary.

A great deal of experimenting was going on at that time relating to the various phases of audion improvement above outlined and many of the specimens produced, of course, were not intended to, and *did* not, embody the particular high vacuum improvement here in issue.[2] However, records were found of a number of the specimens that did embody it, and are in evidence. Defendant's Exhibit 255[3] gives test runs on four or five tubes that stood voltages up to 240 volts without blue glow or other evidence of ionization.

These early tubes doubtless had many faults from the present day point of view, but, for use at the proposed voltages, *gas ionization troubles were not among them.* Beyond question they embodied the improvement due to better vacuum covered by the Langmuir patent.

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[9] Deft.'s Ex. 255, formerly 18, p. 105. Here we translate "miles" of "gain" into the power amplification factor "26 times" by a rule given by van der Bijl, Interf. Rec., pp. 627, 666.

[1] Rec., Vol. 1, p. 517 *et seq.*, Q179; p. 612, Q80.

[2] Rec., Vol. 3, p. 1881, XQs. 46 to 56.

[3] Interference Priority Exhibit 18, pages of Pierce's Notebook.

Philadelphia Tubes.

In September and October, 1913, Arnold's assistant Kendall installed a repeater with high vacuum audions at Philadelphia. After suitable tests and adjustments, this repeater was switched in on the line between New York and Washington for regular commercial service. This was on October 18, 1913, and since that date the commercial use of high vacuum audions as telephone repeaters has never been interrupted, and has expanded enormously.

Most of the tubes which first went into service in the telephone plant in September, October and November, 1913, have, naturally, been lost or destroyed. Three, however, were found and put in evidence, and original data on one other sufficient to show its character, are in evidence. The three tubes in evidence are Audion 6.11, 64 and 100, and the other tube is Audion 9.111.[7]

These tubes were evacuated with the Gaede molecular pump, baked, glowed and the electrodes bombarded just as with the tubes of April and May, above referred to;[8] so they were made as specified in the patent in suit. A contemporaneous record[9] shows that on December 20, 1913, Audion 6.11 had had 152 hours service as a commercial repeater; that Audion 64 had had 56 hours; Audion 100, 96 hours, and Audion 9.111, 267 hours; so there can be no doubt that these tubes showed the steadiness and reliability

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[7] The three tubes in evidence are Deft.'s Exs. 265 (formerly numbered 28), 267 (formerly numbered 30) and 269 (formerly numbered 32). For data of Audion 9.111 see Deft.'s Ex. 271 (formerly numbered 34).

[8] Interf. Rec., p. 2212.

[9] Deft.'s Ex. 264, Interf. Priority Ex. 27.

under service conditions, characteristic of the proper vacuum and which is the very essence of the alleged invention of this patent. The patent itself points out that the removal of gas is to be proportioned to the use to which the tube is to be put, and that *relief from erratic operation is the end to be attained,*—not some particular degree of evacuation.[1]

Besides these controlling facts, there are the original data taken on Audion 9.111 in September, 1913,[2] showing that it stood voltages up to 125 volts and carried currents of over one milliampere without showing blue glow (one of the tests mentioned in the patent in suit for tubes embodying the supposed invention). As to Audions 64 and 100, measurements of their vacuum taken before the trial show one and a half hundredths of a micron for the first and well under one hundredth of a micron for the other.[3] The patent in suit says (p. 5, line 5) the vacuum "should preferably be carried to a pressure as *low as a few* hundredths of a micron" so these vacua were very good indeed, judged by the patent itself. These vacuum measurements were carefully made by a procedure approved by Dr. Millikan[4] and fully described on the stand by Dr. Kelly.[5] Dr. Kelly (who is in charge of the tube manufacture for the Western Electric Company), also made load tests on each of these tubes showing the permanence of their vacuum under working conditions, and states that either of them will operate

[1] Pat. Spec., p. 4, lines 105-110; p. 5, lines 7-10; p. 1, line 60; p. 2, lines 111-114; p. 5, lines 116-130.

[2] Deft.'s Ex. 271.

[3] Rec., Vol. 2, pp. 813, 830, 851.

[4] Rec., Vol. 1, p. 456, Qs. 35-37.

[5] Rec., Vol. 2, pp. 813 to 821.

at upward of 100 volts with a pure electron current amounting to 3/10 milliampere or more for tube 64, and 4/10 milliampere or more for tube 100.[1] These are higher voltages and currents, than specified in a number of the claims of the patent, as for example claims 26 and 29.

The foregoing is the direct and positive evidence as to the character of vacuum, the performance and the usefulness of these Philadelphia tubes.

At various times Respondent has urged various reasons why Arnold should not be awarded priority. However, in the petition for reargument in the Circuit Court of Appeals, all of these reasons were abandoned but one. We shall therefore in this brief refer only to this reason. Referring to a demonstration by one, Richards, of the Western Electric Company to some company officials in February, 1913, in which he used DeForest audions instead of more highly evacuated tubes made by Arnold, the argument was advanced that the higher vacuum tubes would have been used if Arnold had been then able to produce them. There is absolutely no point in this criticism. The demonstration had relation to the *quality* of audions, not their *power capacity*. It was intended to show that a large number of them could be connected in series or tandem without introducing distortion of the speech currents. The telephone system was then using mechanical repeaters but they were not good enough to work *in tandem*.[2]

The test showed that it was possible to use as many as seven of the audion type repeaters in tandem and so served its entire purpose. It was, as a matter of fact, a distinctly by-the-way incident and not at all an important or official

[1] Rec., Vol. 2, p. 826, Q29; p. 835, Q50.
[2] Rec., Vol. 1, p. 403.

test, as Respondent has sought to imply. Arnold was then waiting for the arrival of the new Gaede molecular pump and there was no reason why a special effort should have been made to produce, for that test, higher vacuum tubes than the audions which were on hand.

Langmuir's Work.

Langmuir's Two Preliminary Statements.

November 1, 1912 being clearly proved as the effective date of invention by Arnold, the defense based upon Arnold's priority is established unless Langmuir can show at least a *conception* of the supposed invention prior to that date, coupled by due diligence with a reduction to practice.

When the priority controversy began in the Patent Office in 1916, Langmuir did not even *allege* an earlier date of invention than November 1, 1912.

Each party to an interference is required to file a sworn "preliminary statement", before he knows anything of his opponent's case, telling when he claims to have conceived, disclosed, and reduced to practice, the invention in controversy. *Langmuir's first preliminary statement* filed August 21, 1916,[1] *says that he conceived, disclosed and reduced to practice, all* "during the month of November, 1912".

Arnold's preliminary statement filed about the same time gives dates in the same period.

It is the regular practice of the Patent Office, when a party gives an indefinite date close to the date alleged by his opponent, to require of him a more definite statement. Accordingly, in a letter from the Patent Office dated Sep-

[1] Interf. Rec., p. 1994.

tember 8, 1916, Langmuir was required to give "a more definite date" than "the month of November".[3]

Of course Langmuir's attorney knew what this meant. He telegraphed to Washington for more time on the plea that this would "require extensive investigation",[3] and then in due course came in with a new statement alleging conception, disclosure, sketches, written description, and reduction to practice,—all—"between the middle of July, 1912 and the first day of September, 1912".[4]

And there is a singular thing about the language of this second statement that is worth noting. The *first* statement said that he "conceived the *invention*", on the date alleged; the *second* said he conceived a "*device embodying* the invention", on the date alleged.[5] The distinction may seem slight at first glance but, in the light of the subsequent testimony as to what Langmuir really did in this earlier period, it is very significant, for the language is, in effect, a subtle admission that Langmuir was not at that time conscious of the *invention* but only of some physical "device", *now* claimed to have embodied it. That, of course, would not be invention at all. And this, precisely, is one of the fatal defects in Langmuir's work prior to November 1, 1912 so far as its effect in this controversy is concerned.

This work of Langmuir's, prior to November 1, 1912 (which we shall refer to as the August work) does not establish even a conception of the supposed invention, for

[3] Rec., Vol. 6, p. 1069.
[3] Rec., Vol. 6, p. 1070.
[4] Interf. Rec., p. 1995.
[5] This point did not escape the notice of the Commissioner of Patents, and he comments on it in his decision (Interf. Rec., p. 2516).

two reasons, either of which is sufficient to make it worthless here: *first*, he did not then realize that the alleged invention was embodied in the tube relied upon, *as he fully admits; second*, the supposed invention was, in fact, not embodied there.

Langmuir Did Not Recognize the Invention in August, Assuming Its Presence.

The essence of every invention, in the very nature of the case, is the "conception",—the mental act by which the new idea comes into existence. To be rewarded by the patent law the conception must also be put into concrete form by a "reduction to practice",—either actual or by filing a patent application—but, as must be obvious and as the decisions cited hereinafter show, an accidental physical embodiment without a conception is no invention at all. *Clearly there can be no such thing as a conception of which the inventor is not conscious,—it would be a contradiction of terms. Equally clearly no physical thing can be the "reduction to practice" for an unconceived idea; for it is the ability to instruct others, which flows only from a consciousness of the idea, that the patent law stands ready to reward.*

And so it has always been held that no physical structure can serve to establish either a conception or reduction to practice for any claimant unless, at the time, he appreciates the fact, if true, that it embodies the improvement in question. Robinson on Patents says:

> "Moreover, no exercise of the creative faculties can form a part of the inventive act, unless the idea resulting from such exercise is fully apprehended by

the mind of the inventor. To create by accident without a recognition of the fact or nature of his own creation, and consequently without the power to repeat the same creative act, is not invention. While previous intention to create in this especial form, or even to create at all, is not required, it is essential to the inventive act that the inventor should not only *conceive*, but should also *perceive* his original idea, and should do both so clearly as to make this idea an actual addition to his fund of knowledge, and to be able to communicate it to the public."[6] (Italics the author's.)

This Court, in *Tilghman* v. *Proctor*, 102 U. S. 707-711, in disposing of several alleged anticipations of the Tilghman patent said:

"We do not regard the accidental formation of fat acid in Perkin's steam cylinder from the tallow introduced to lubricate the pistom (if the scum which rose on the water issuing from the ejection pipe was fat acid) as of any consequence in this inquiry * * *.

"The accidental effects produced in Daniell's water barometer and in Walther's process for purifying fats and oils preparatory to soapmaking, are of the same character. They revealed no process for the manufacture of fat acids. If the acids were accidentally and unwittingly produced, whilst the operators were in pursuit of other and different results, *without exciting attention and without its even being known what was done* or how it had been done, it would be absurd to say that this was an anticipation of Tilghman's discovery."

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[6] Vol. 1, Sec. 79, p. 121.

In *Pittsburgh* v. *Cowles*, 55 Fed. 301-307, Judge TAFT, late Chief Justice, said:

> "But suppose it be a fact that in DeVille's process alumina was dissolved in the bath from the anode and that thereupon it was electrolyzed as in the Hall process. It was a mere accident of which DeVille made no note and which therefore we may reasonably infer he did not observe. Accidents of this character cannot be relied on as anticipations of a patented process * * * *when the operator does not recognise the means by which the accidental result is accomplished* and does not thereafter consciously and purposely adopt such means as a process for reaching the result. DeVille did not intend that the alumina should be dissolved in the bath. If he did, why did he unite it with carbon by means of pressure and a binding material? *If he had intended to dissolve the alumina, he could not have done anything which would have so interfered with his purpose.*"

(The application of this case to Langmuir's work will be apparent from the fact we refer to below that as soon as the alleged high vacuum occurred in his August tube, it was again refilled with nitrogen gas; Rec., Vol. 2, p. 1349, XQs. 455, 456).

To the same effect are

Eibel v. *Minnesota*, 261 U. S. 45-66;

Wells v. *Curtis*, 66 Fed. 318-322, C. C. A., 6th Circuit;

Andrews v. *Carmen*, Fed. Case 371;

Munising v. *American*, 228 Fed. 700-703, C. C. A., 6th Circuit;

Anthracite v. *Pollock*, 175 Fed. 108-111;

Doble v. *Pelton Co.*, 186 Fed. 526-532;
Byerley v. *Barber Asphalt Co.*, 230 Fed. 995-997;
Standard Co. v. *Graywood*, 1 Fed. (2nd) 667-670;
Carson v. *American Co.*, 11 Fed. (2nd) 766-771, 772, C. C. A., 9th Circuit.

In the August work, what Langmuir had was a vacuum tube with a hot filament and a cold filament, which he was using to study the rate at which nitrogen was "cleaned up" during the passage of the Edison current across the space. He *now* claims that on some of the runs with this tube, he had a vacuum through which there was a pure electron discharge unaffected by positive ionization. *But he admits that he was not then conscious of the alleged fact.* He testified:[8]

> "XQ380. You did not know at the time, or you did not suppose at the time, that you had a pure electron discharge substantially unaffected by positive ionization, did you?
>
> A. *No, I did not draw that conclusion at that time. I know it now but I did not know it then.*"

And like admissions are contained elsewhere in the record. See Interference Record, pages 1560, 1569 and 2094.

So that, even if the supposed invention here were merely an electron discharge substantially unaffected by ionization, the August work would not show a conception of it.

But the invention, as we have seen, can not *merely* be this (which was already known in the art, *supra*, p. 31). It must at least include the idea of *applying the principles* governing such a discharge *to the useful purpose* of improv-

[8] Rec., Vol. 2, p. 1328.

ing vacuum tubes for amplifying, etc. *There is not one word of evidence in the whole record that Langmuir had any conception of this, or any other useful result to be secured by such a discharge prior to November 1, 1912, nor for some time thereafter.*

Our opponents argue that the tube Langmuir then had *could* have been used for rectifying alternating currents with improved results. This is not true because it is recognized the rectifiers, like detectors, work better with considerable residual gas. But if true, it would make no difference. The only important inquiry is whether Langmuir *then recognized* such alleged fact. His admission, above quoted, answers that.

So no matter *what* the August work was, it is of no consequence here.

The August Tube Did Not in Fact Embody the Invention.

But evidence taken *before the Trial Court* which was *not before the Patent Office* shows that the August tube was, in fact, not an instance of "pure electron discharge substantially unaffected by ionization", as Langmuir now claims,—much less an example of the application of such a discharge to a useful purpose,—so that even had Langmuir recognized the full truth about the discharge at its highest vacuum points, still he would have been far from the supposed invention.

Langmuir says that a sudden drop in the space current which he got at times in the August tube, from about 16 milliamperes to about 5 milliamperes, as the nitrogen gradually cleaned up, indicated the disappearance of ionization effects. He is wrong. What it really indicated was the

beginning of the space charge effect,—still greatly affected by ionization.[9] Space charge alone means nothing. It is not even mentioned in Langmuir's original application. Respondent admits that the old DeForest audions had it. Only when the space charge is substantially *unaffected by positive ionization* does it begin to have any significance here. It is upon the substantial *absence of ionization* that the original application repeatedly insists, and upon which Arnold insisted in his November 1st disclosure.

The presence of substantial ionization in the August tube is shown first by the very fact of the sudden change of current value[1] and also by the fact, shown by Langmuir's own data, that every reduction in gas pressure thereafter was followed by a further drop in current.[2] Also Becker testified that he duplicated this experiment and then continued to reduce the gas pressure in steps to a really good vacuum, and he found that the current continued to fall,—as the gas was removed—, to about one-half or one-third of what it was soon after the drop. Langmuir stopped when it had decreased only 20%. This shows beyond question that Langmuir's discharge was very materially affected by the gas ionization.[3]

Langmuir also points to a logarithmic plot of two points, taken in two different runs, at 250 and 200 volts, respectively,[4] as indicating that the discharge was substantially unaffected by ionization because, as he says, the slope of the line connecting these points is nearly 1.5, thus conforming nearly to the 3/2 law. But on cross-examination, he ad-

[9] Rec., Vol. 3, p. 1792, Qs. 7 and 11.
[1] Rec., Vol. 3, p. 1796, Q. 11.
[2] Same, Q12.
[3] Same, Qs. 19 and 20.
[4] Interf. Rec., p. 2091.

mitted, after some urging, that the actual slope through the points was 1.83 rather than 1.5,[5] and that plotting just those two points didn't have much significance anyway![6]

Moreover, in his "Physical Review" paper of December, 1913, page 470[7] Langmuir exhibited a logarithmic plot of an experimental run with a vacuum tube of like character which showed a large number of points, giving a slope of 1.71; and comparing this with the theoretical 1.5 slope he said in that paper, "This difference is certainly due to residual gas"; yet he asks the Court to believe that a plot of *two* points showing a slope of *1.83* with a tube of the same kind, means *no* gas effect![8]

It does not seem to us necessary to discuss the August work any further.

Langmuir admits that he did not then know what sort of discharge he had. The facts show that he did *not* have a discharge unaffected by ionization. And it is not even *claimed* that he then thought of applying such a discharge to a useful purpose.

Langmuir's Case After November 1, 1912.

Since Respondent has failed to show even a conception for Langmuir prior to Arnold's date of November 1, 1912, the defense of prior invention by Arnold is established, and the patent is accordingly invalid. Nothing Langmuir may

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[5] Rec., Vol. 2, p. 1346, XQ443.

[6] Same, XQ450.

[7] Pltf.'s Ex. 21.

[8] Even to get his 1.83 he had to carefully choose this pair of points out of many. Other pairs would have given slopes anywhere from .953 to 2.58; see Deft.'s Ex. 295 (Rec., Vol. 6, p. 1202; Vol. 3, pp. 1797-8).

have done after November 1, 1912, can give him priority, because it is too late.

As to the priority issue, we might logically rest our case here.

There are, however, one or two things after November 1st in Langmuir's story which show so clearly that he did *not* have the invention until a much later date, that we shall take space to refer to them briefly.

Langmuir's November Experiments.

Between the 18th and 22nd of November, 1912, Langmuir made some more experiments on tubes generally similar to his August tube,—i. e., with two electrodes, both filamentary. This time, however, he was watching changes in the Edison current as the filament temperature was changed, rather than the clean-up effect upon the gas. He made the experiments because Richardson, the great authority on thermionic discharges, was coming to Schenectady to make an address, and Langmuir wanted "to get an understanding of the fundamental laws involved".

What he did was to apply a single voltage between cathode and anode,—(sometimes 125 volts and sometimes 250 volts)—, then vary the heating current of the filament in steps and note the resulting variations of the Edison current.

The great trouble with Langmuir's attempt to rely on these experiments in this controversy is that they make no pretense of being anything but investigations in pure science. There is evidence that they did serve to instruct Langmuir in some "fundamental principles" (already known to others) but there is not one word of evidence

that they stirred in his mind the faintest glimmer of an idea that these principles could be turned to a definite useful purpose.

Langmuir himself says that the experiments were undertaken

> "* * * in order to get an understanding of the fundamental laws involved, and thus settle once for all whether or not pure electron currents could be obtained in a practically perfect vacuum"[9]

and

> "* * * with the object of measuring the electron emission from tungsten filaments in the best vacuum, or at least, a very good vacuum".[1]

That was his state of mind *before* the experiments. What was it afterward? At the time he testified in the interference, he said this:

> "Their importance to my mind lay in the fact that they gave a clear understanding of the characteristics of a pure electron discharge in high vacuum at high voltages. They enabled me to understand clearly the distinction between the space charge part of the curve and the saturation part of the curve, and to realize that on the space charge part of the curve, the current is independent of filament temperature but depends upon the voltage of the anode, and the area of the anode".[2]

Pure unapplied science. One may know all these things and yet not appreciate any useful application for them. In fact, they all were known to others, as shown by the references herein to the work of Lilienfeld and by the work

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[9] Interf. Rec., p. 557—top.
[1] Rec., Vol. 2, p. 1139—top.
[2] Interf. Rec., p. 2109, lines 5-14.

of Richardson and Child;[3a] and they, like Langmuir, had noted them simply as scientific facts.

It is an axiom of patent law that patentable invention lies in producing practical results in the useful arts, not in merely discovering scientific facts or principles.[3] *LeRoy* v. *Tatham*, 14 How. 155-174; *Detmold* v. *Reeves*, Fed. Cas. No. 3831; *Morton* v. *N. Y. Eye Infirmary*, Fed. Case 9865.

At the end of this November work, then, it is clear that Langmuir was not possessed of the invention.

Coolidge-Langmuir Conversation in December.

Plaintiff has emphasized an alleged disclosure of the invention by Langmuir to Coolidge on December 10, 1912, as to which both men gave testimony. At that date X-ray tubes commonly had gas and cold cathodes, and Coolidge entertained the idea of an X-ray tube without gas and with a hot cathode. In ignorance of the prevailing scientific knowledge, both Coolidge and Langmuir had doubted whether a hot cathode would emit electrons in the absence of gas. According to respondent's contention, the whole sum and substance of the alleged disclosure was that Langmuir encouraged Coolidge to suppose—what the scientific world well knew—that a hot cathode would emit electrons in the absence of gas.[4] If, as respondent asserts, the X-ray tube of the Coolidge Patent No. 1,203,495[5] grew out of this encouraging remark from Langmuir to Coolidge, that was

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[3a] Child, Rec., Vol. 5, p. 437; Richardson, Interf. Rec., pp. 226 *et seq.*

[3] Robinson on Patents, Vol. 1, Section 96, p. 142 and Section 231, p. 314.

[4] Compare Coolidge's answer to Q103, Rec., Vol. 3, p. 1512, with the statements in Lilienfeld's 1910 paper, for example, at Rec., Vol. 5, pp. 316, 325, 356 and 392.

[5] Rec., Vol. 6, p. 1021.

the only invention that grew out of it. Having elected to claim it for Coolidge, the General Electric Company cannot now claim it for Langmuir (*post*, p. 106).

The theory of the General Electric Company is that Langmuir was the inventor of the "broad aspect" and Coolidge was the inventor of the X-ray tube.[6] But a "broad aspect" is not an invention. No invention of apparatus comes into existence until someone has in his mind a conception of specific apparatus functioning to accomplish some definite, desirable, useful purpose. To disclose an invention one must disclose a complete idea of means to accomplish such a purpose. The only definite practical purpose entertained by Langmuir and Coolidge, was to construct a certain kind of X-ray tube. What was said between them fell far short of an adequate disclosure of a complete idea of means for that purpose, as Respondent freely admits.[6a]

Hence, the alleged disclosure by Langmuir to Coolidge fails, (1) because the only invention mentioned was an invention that Respondent has elected to claim for Coolidge instead of Langmuir, and (2) because according to Respondent's admission a complete idea of means was not reached until a much later date. But even if the conversation between Langmuir and Coolidge could be considered to show a realization on the part of the former of a useful purpose to which a pure electron discharge could be put, it is of no importance in this case, because Arnold antedated him by a month and a half.

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[6] See paragraph preceding the claims in the Coolidge Patent, Rec., Vol. 6, p. 1026.

[6a] Main brief in court below, p. 222, top; "it took Coolidge months of hard work before he was ready to file his application for this patent".

Langmuir's Record After 1912.

The time of Langmuir's actual conception is not left to speculation. His own record shows exactly *when* it was and *what* it was. And it was, as we have already remarked, exactly the thing Arnold had conceived some months earlier, namely, a DeForest audion with a better vacuum.

Langmuir got his first audion early in February, 1913, and put White to studying it.[7] Some two weeks later they were testing one of their own make but found that even the 0.1 micron vacuum they had would not "stay put"—apparently because gas poured out of its electrodes when in use.[8]

Then after about a month more of groping[9] he sees the light, and writes in his note book under date of March 21, 1913:

> "Now what I intend to do is to construct an audion which will operate entirely and exclusively on the electron discharge. I shall attempt to get the vacuum so good that positive ions are present in negligible amounts".[10]

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[7] Pltf.'s Ex. 101, Interf. Ex. 81, p. 242.

[8] Same, pp. 305, 308, 309.

[9] One may trace his steps from his own notes, Pltf.'s Ex. 101, pp. 287, 298, 299 and 306, and Pltf.'s Ex. 131 (Interf. Ex. U), pp. 32 and 33. He has wholly wrong ideas of the audion operation, as to "sensitiveness" and "sluggishness" for instance; as to electron emission from Wehnelt cathodes, etc.

[10] Pltf.'s Ex. 131, p. 34, Interf. Ex. U. The plain meaning of this paragraph cannot be explained away, as has been attempted by Respondent. The words "This we have already done" on the following page of the notebook obviously refer to the attainment of sensitiveness by proper electrode structure and spacing, the description of which they immediately follow.

Here is Langmuir just taking the step that Arnold took nearly five months before! And still he is not sure. He says he will "attempt" it; Arnold spoke with such assurance that his department was straightway reorganized on the strength of his statements, to put them to commercial use.

So we think the fact that Langmuir did not have the invention prior to November 1, 1912, is shown not only by the failure of his proofs as to that period, but by the above mentioned positive evidence from his own note books as to events subsequent thereto. Going on in these note books we find many entries to show that he was slow to effect a practical use of the invention, as he had been to attain its conception. On the date December 19, 1913 he wrote

> "*Proposed Demonstration* of our devices for wireless telegraphy and telephony.
>
> Hawkins says Davis is going to try to arrange to have us demonstrate our devices to the Marconi Company and the Western Electric Company. I pointed out that we should *first arrange a trial demonstration with some wireless experts friendly to us,* or preferably in our employ. Hawkins suggested getting in touch with the wireless men at Pittsfield. I spoke to White and Dushman and asked White to arrange all his work with the end of preparing apparatus for demonstrating the following lines of work
> . . . ."[1]

Langmuir's precaution to "first arrange a trial demonstration with some wireless experts friendly to us" was well

[1] Pltf.'s Ex. 132 formerly priority Ex. V, p. 82.

conceived, for with date June 18, 1914, he records an effort extending over several days, the culmination of weeks of preparation, the object being to effect a wireless telephone transmission between Schenectady and Pittsfield, less than 50 miles. All that was accomplished was that a portion of the phrase "Hello, White" was heard at one time.[1a] It was in April, 1915, ten months later, when the "Proposed Demonstration" was carried out and Langmuir showed his products to Arnold and his associates.[1b] It will be remembered that the Arnold tubes had been used commercially by the Telephone Company beginning in October, 1913, and that they were actually used in the first transcontinental telephone line in the summer of 1914.

Resumé on Priority.

It thus appears from the overwhelming weight of the evidence (some of which was not before the Patent Office Tribunals) that Dr. Arnold conceived the alleged invention of the patent and disclosed it to others on November 1, 1912, and thereafter used due diligence in reducing it to practice, so that by the following October, tubes embodying the alleged invention of the patent were in commercial use as repeaters in the lines of the American Telephone & Telegraph Company, and in the following year were used as repeaters in the first transcontinental line ever built. On the other hand, Langmuir cannot be said to have made any invention until long after November 22, 1912, when, so he testified, he was conducting experiments to "settle once for all whether or not pure electron currents

[1a] Plf.'s Ex. 132 formerly priority Ex. V, pp. 329 to 331.
[1b] Interf. Rec., pp. 484 to 487.

could be obtained in a practically perfect vacuum". After he discovered that they could be so obtained, he apparently conceived no useful purposes therefor until March, 1913, when he wrote in his notebook that he intended "to construct an audion which will operate entirely and exclusively on the electron discharge". Moreover, although the Arnold repeaters were being used in commercial telephone lines in the fall of 1913, and in the transcontinental line in the summer of 1914, the first practical thing we find done by Langmuir with his tubes, was the attempted wireless telephone transmission of less than fifty miles in June of 1914 where only a part of the phrase "Hello White" was heard.

It is clear therefore that if the Langmuir patent discloses any invention of a patentable nature, Arnold was the first inventor and not Langmuir. The Langmuir patent is obviously invalid for this reason, as was held by Judge Morris and Judge Woolley.

The majority opinion of the Court of Appeals did not advance any reason for a different conclusion as to the effect of Arnold's work, nor point out any error in the conclusion of the lower Court, nor criticize its reasoning. The Court of Appeals was in error in not upholding Arnold's priority and should be reversed on that ground.

POINT IV.

The patent is invalid because of prior knowledge and public use.

This defense was sustained by the District Court and by Judge WOOLLEY, and is not referred to in the majority opinion of the Court of Appeals.

Facts of Detector and Amplifier Operation.

As to this defense, the established facts are as follows:

1. It is abundantly shown by the record (and stated in the Langmuir patent) that the ordinary DeForest audion *detector* was recognized as a gas device and as such had an ionizing voltage of about 25 volts. It was and is therefore, customary to use the same with an impressed voltage of approximately 22½ volts.[1]

2. When voltage very slightly *above* ionizing voltage (25 volts) was impressed upon the DeForest audion *detector*, it would "blue glow".

3. The use of an audion as an *amplifier* was known prior to August, 1912, the earliest date claimed by Langmuir.

4. When "blue glow" appears, due to ionization at an impressed voltage very slightly above the ionizing voltage, the amplifier becomes inoperative.[2]

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[1] Hogan was never able to use more than 30 volts with an audion detector prior to 1914; XQ46, p. 100, Vol. 1.

[2] Hogan XQ35-XQ39, p. 97, Vol. 1, Rec.

All of the foregoing facts are not only conclusively established, but are undisputed.

It is perfectly obvious at the outset, therefore, that if an audion tube was used or was capable of being used as an *amplifier* with voltages over 25 or 30 volts, *it was so used or capable of being used only because the gas in the tube had been evacuated to a degree which would permit the use of such higher voltages.*

Facts of This Defense.

The facts of the California use may be briefly narrated as follows:

The Federal Telegraph Company of California, for whom Dr. DeForest was working in 1911 and 1912 (until September of that year), was engaged in the commercial transmitting and reception of radio messages. This work included the employment of audion *detectors* as well as audion *amplifiers*. The amplifiers were "three stage amplifiers", *i. e.*, three audion *amplifiers* connected in series or tandem. The audion tubes used as *amplifiers* were distinguished from and classified apart from audions used as *detectors*. It is, of course, common knowledge that when an audion is used as an *amplifier*, the higher the voltage impressed between the plate and filament, the greater the amplification secured. We therefore find Dr. DeForest writing to the McCandless Company (the concern which manufactured DeForest audions for the Federal Telegraph Company) under date of July 26, 1912,[8] as follows:

> "Out of the last lot of 24 audion bulbs which you manufactured for us there are only 4 that came up to

[8] Defts.' Ex. 79*a*, p. 1061, Vol. 6, Rec.

proper sensitiveness test. Apparently the vacuum in the other bulbs is too low, because in these latter bulbs we notice that the blue arc or cathode beam starts suddenly at 15 or 20 volts, under which condition the bulb is not sensitive."

The operators of the commercial stations of the Federal Telegraph Company, using the DeForest audions, encountered the trouble of "blue glow" when the voltage on the plate was increased, and discussed the matter with Dr. DeForest. He explained to them that the vacuum was not high enough. This, of course, was entirely consistent with DeForest's letter to the McCandless Company. Likewise, the question was discussed as to where else, other than by the McCandless Company, could evacuation of the bulbs be secured. Dr. DeForest located a glass blower in San Francisco, by the name of Lamont, who put in tungsten filaments and repumped the tubes at DeForest's request. As a result, Dr. DeForest wrote the McCandless Company under date of August 14, 1912,[4] stating, in part, as follows:

"We took two of the poorest of the discarded 20 to a San Francisco glass-blower, unknown to fame, *and had him exhaust same to as high a vacuum as his pumps would take.* These reexhausted bulbs now show a sensitiveness equal to those of the first four, *which proves conclusively that our contention is correct. For the work which we demand from these bulbs they are not sufficiently sensitive and we would be glad therefore if you will reexhaust them.* You certainly should be able to put them in as good condition as the aforesaid San Francisco glass-blower."

[4] Deft.'s Ex. 79B, p. 1062, Vol. 6, Rec.

We here see, therefore, that for use as an *amplifier*, De-Forest not only realized that he wanted a higher degree of vacuum, and that the degree of vacuum he wanted should be as high as possible, but that he made a record of his knowledge of this fact, not in the sense of establishing a date of invention, however, because it is evident from De-Forest's correspondence and his operations in California that a difference in the degree of vacuum was not considered by him to be an invention, but a mere manufacturing operation.

Amplifier tubes were employed by the Federal Telegraph Company in 1911, 1912 and 1913 and formed part of its standard commercial equipment [5] with a B battery comprising 36 cells (54 volts).[6] We further find that Hewlett used a three electrode tube evacuated on Lamont's pump with 45 cells in series.[7] Forty-five cells gives a voltage of 67½!!

Testimony from Langmuir Bearing on the Facts of This Defense.

From the foregoing, it is apparent that these devices operated at voltages much above gas ionization voltage (25 volts) and still functioned as amplifiers in amplifier circuits; hence they could not have operated otherwise than as "pure electron flow devices". And this is established by Langmuir's own testimony [8] in connection with his diagram.[9] Langmuir was asked,—

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[5] See Beale blueprints, Deft.'s Exs. Nos. 81 and 82, pp. 1065-1067, Vol. 6, Rec.

[6] Beale testimony Qs. 18 and 19, p. 1052, Vol. 2, Rec.

[7] Q14, p. 1008, Vol. 2, Rec.

[8] P. 1427, Vol. 3, Rec.

[9] Pltf.'s Ex. No. 168 E, reproduced on p. 55, Vol. 4, Rec.

"XQ761. I want to ask you just one question in connection with Plaintiff's Ex. No. 168, which was the curve of the output against the plate voltage of a three electrode device, as an amplifier with gas, and a three electrode device, as an amplifier without gas, and I think that you testified as the result of the experiments on which this curve was based, that there is a point in a gassy tube where it operates in a very successful manner as an amplifier; is that correctly stated?

"A. Yes.

"XQ762. And I notice that your curve stopped on the gassy tube when you brought the voltage up to forty volts, the point being well below the steep part of the curve, which I understood you to state was the operating portion of the curve; is that correct?

"A. Of course this is not a volt ampere characteristic at all.

"XQ763. I understand that it is the amplifying quality of the tube, is it not?

"A. Yes, but in your reference to the upward bending part of the curve, I think you were referring to volt ampere characteristics, that I had previously spoken of and this is not at all comparable with that.

"XQ764. I see, but as I understand this curve, the higher up on the millivolt ampere output ordinate that you go, the more sensitive the amplifier is; was that the purport of your testimony?

"A. Why, we were plotting as ordinates the amplifying power, *the amplifying power reached to a maximum at about twenty-seven volts.*

"XQ765. *And the amplifying power of the tube at forty volts reached how much?*

"A. *Well, it was very small; about 0.34.*

"XQ766. *And what would have been the amplifying power of the tube, if you had raised it to fifty volts?*

"A. *Probably very much less.*

"XQ767. *In accordance with the slope of the last portion of the curve, it would be practically nothing, would it not?*

"A. *Very likely.* I do not know that. You can not safely extrapolate, because you go to higher voltages, the current becomes limited by saturation from the filament, *and then the amplifying power becomes zero, and remains zero, as higher voltages are reached.*"

From the foregoing testimony in connection with Plaintiff's Exhibit No. 168E, it is perfectly apparent that *maximum amplifying power of an amplifier tube containing gas is secured at approximately 27 volts,* and the Court will see that a mere fraction of a volt above that causes the amplifying power of the tube to drop to practically zero. It is therefore obvious that *it would have been impossible for the Federal Telegraph Company to employ audion amplifiers in their commercial operations with voltages of 30 volts or more without* (*a*) blue glow and hence paralysis of the tube, and (*b*) with any amplifying power whatsoever, *unless the tube had been evacuated below the degree of vacuum contained in a soft audion detector tube which was the only type of audion Langmuir in his patent acknowledges as prior art.*

In this connection, attention is called to claim 26 of the patent which covers an electron discharge device operating at 40 volts. Obviously, the amplifiers used at the Federal Telegraph Company's stations would infringe this claim, because they operated with over 40 volts. If they infringe *any* claim they embody the *invention* of the patent, *and if they infringe if later, they anticipate if earlier.* The only

difference between claim 26 and the remainder of the claims is in the recitation of the *characteristics*, which are inherent in the operation of such a tube, or the recitation of different values of voltages and currents. It is believed that it is too obvious to require discussion, that the claims specifying 50, 60, 100 and 200 volts do not describe separate inventions from those specifying 40 volts. Otherwise we might as well have a thousand claims to as many separately patentable inventions by the simple expedient of increasing the specified voltages by small steps.

It is indeed significant that Langmuir made no reference in his patent to the use of an audion as an *amplifier*. It is indisputable that his description of the audion and its limitations as to gas content and operating voltages was incomplete and inaccurate.

Tungsten Cathodes in the California Tubes.

Another avenue of approach is that of considering the inherent results of using tungsten as the filament in a vacuum tube. Langmuir stated in his paper of 1915, in the proceedings before the Institute of Radio Engineers:[1]

> "It was known that the vacuum in a tungsten lamp is extremely high, and measurements indicated that in well exhausted lamps after one hundred hours life, *the pressure was probably less than one-millionth of a millimeter of mercury.*"

This was due to the "clean up effect" of tungsten to which many references appear in the record. It therefore follows as a logical result that the mere existence of a

[1] He confirmed the same in his testimony in answer to XQ730, p. 1419, Vol. 3, Rec.

tungsten filament in an audion tube would inherently cause the vacuum to be much improved.[2]

Likewise the record is replete with references to the standard incandescent lamp practice of "flashing" the filament, so as to produce "blue glow". In other words, in the manufacture of incandescent lamps, a "blue glow" was intentionally brought about and Dr. Dushman points out in his book:[3]

> "In general, *over 90% of the residual gas is cleaned up in a lamp during the blue glow.*"
>
> * * * * * * *
>
> "and the rate of clean up during this time is much more rapid than that obtained subsequently. The final pressure attained in flashing varies from 0.01 to $0.001 \times 10 = 3$ mm.[3a] of mercury".

Mr. Hogan's translation of this (in answer to XQ366) is

> "If, I heard you, it is .01 to .001 microns."

It will thus be seen that if a tungsten filament is employed in an audion tube, and if given the usual "flashing" treatment, the vacuum is inherently reduced to a degree well within the limit specified by Langmuir, and hence the device automatically comes within the scope of the alleged invention.

With these facts in mind, consider the evidence showing how the DeForest tubes were repumped in California. We find from the depositions of Lamont and Mrs. Beck that new filaments were always inserted from 1911 on. *We find that these filaments were tungsten filaments.* We find from

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[2] See also XQ743, p. 1421, Vol. 3, Rec.
[3] See XQs. 364-366, inc., pp. 1657-8, Vol. 3, Rec.
[3a] Misprint for 0.01 to 0.001×10^{-3} mm.

the deposition of Ralph Hyde, that the filaments he employed were drawn tungsten filament, i. e., thoriated tungsten filaments. Hyde testified that from 1911 on he repumped and replaced filaments of vacuum tubes.[4] He also testified:

> "Q17. What material filament did you use for the repair or replacement work? A. *Drawn Tungsten* wires.
>
> "Q18. Did you use any other filament? A. No, you mean since I started, from that time up to the present?
>
> "Q19. I mean up to 1914, particularly? A. *Nothing but drawn tungsten wires.*"

It developed from his testimony that the drawn tungsten wire that he used was obtained from the General Electric Company.

Counsel for Respondent admitted in the record for the purpose of this point at pages 1442, 1443, Vol. 3, Record, that thoriated tungsten filament lamps were put on the market in the fall of 1912.

The fact then is, therefore, that beginning as early as 1911, tungsten filaments were used with audion tubes and that by reason of their inherent "clean-up" effect, a higher degree of vacuum was obtained which readily permitted their use as amplifiers. To operate as such they had to function, "without appreciable gas ionization" and they used voltages substantially above ionizing voltages.

But this is all that the Langmuir invention is said to be.

We submit, therefore, that the patent is invalid because of this prior use which has been conclusively established, and as held by Judge Morris and Judge Woolley.

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[4] Q6, p. 995, Vol. 2, Rec.

POINT V.

The present majority decision of the Court of Appeals has reversed the dispositive findings of fact of the Trial Court without advancing any reason therefor, and without mention of those facts or the defenses to which they were directed.

Judge Morris, in the District Court, held that the patent was invalid for the reasons, *inter alia*, (a) prior invention by Arnold[7] and (b) prior knowledge and use by Dr. De-Forest and the Federal Telegraph Company of California[8].

We have considered the evidence bearing on these two separate defenses (*supra*, pp. 55-103). The trial of the cause consumed more that four weeks, extending from October 11, 1926, until November 11, 1926. Over three weeks of this time were consumed in the taking of testimony and evidence bearing exclusively on the fact issue of priority of invention by Arnold.

On this issue Petitioner presented, in open court, the testimony of eight witnesses. Respondent, likewise, on this issue presented the testimony of six witnesses. Sharp issues of fact were raised, and the solution thereof was largely dependent upon the credibility of witnesses.

These issues were determined by the Trial Court after seeing and hearing the witnesses testify and observing their demeanor and attitude while testifying. The Trial Court held, on this evidence, that if the subject matter of the Langmuir patent was patentable at all, it was first invented

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[7] Point III, *ante*, pp. 55 *et seq.*
[8] Point IV, *ante*, pp. 95 *et seq.*

by Arnold and not by Langmuir, and held the patent invalid for this reason.

Similarly, Petitioner produced the depositions of nine witnesses taken in California bearing on the defense of prior knowledge and use. Testimony of two witnesses was given in open court by Respondent, directed to the same subject matter.

The Trial Court, on this evidence, likewise sustained this defense.

The Court of Appeals, after the first hearing, in its *per curiam* opinion adopted as its own the findings and conclusions of the District Court (with Judge BUFFINGTON dissenting *without opinion*). On rehearing, however, the majority of the Court of Appeals reversed the above findings of fact of the Trial Court, which alone were dispositive of the litigation, without referring to the evidence, the defense to which it was directed, or the findings of the Trial Court, and hence without giving any reason whatsoever for so doing.

The rule of law applicable to the findings of fact by a Trial Court was stated by Mr. Justice HOLMES in *Adamson v. Gilliland*, 242 U. S. 350, in the concluding paragraph of the opinion at page 353 as follows:

> "Considering that a patent has been granted to the plaintiff, the case is preeminently one for the application of the practical rule that so far as the finding of the Master or Judge who saw the witnesses 'depends upon conflicting testimony or upon the credibility of witnesses, or so far as there is any testimony consistent with the findings, *it must be treated as unassailable.*' Davis v. Schwartz, 155 U. S. 631, 636."

In the case at bar there was a conflict of testimony and the necessity of the Trial Judge passing upon the credibility of witnesses. Not only was there testimony "consistent with the finding" of the Trial Judge but, as a reading of his opinion will demonstrate, and as we have shown, no other finding could reasonably have been made.

The reversal of the District Court by the Court of Appeals, under such circumstances, we assign as an error which should be corrected by this Court.

POINT VI.

The patent is invalid because of double patenting.

The Court below did not pass upon this defence.

The Langmuir patent in suit is void for the reason that Langmuir's assignee, the General Electric Company, previously sought and obtained a patent on the same invention in the name of its employee William D. Coolidge.

The application [1] for the Coolidge patent 1,203,495 [2] was filed on May 9, 1913. It disclosed the conception of a pure electron discharge tube, and particularly exemplified this disclosure in a high vacuum hot cathode X-ray tube. Thus, it disclosed the invention now claimed in the Langmuir patent and, quite unlike the original application for the Langmuir patent, the original application for the Coolidge patent *claimed* that invention.[3] It is clear that in May, 1913 the General Electric Company considered that the only patent-

[1] Rec., Vol. 6, p. 941.

[2] Rec., Vol. 6, p. 1021.

[3] See for example, claim 9 of the original Coolidge application, Rec., Vol. 6, pp. 957, 958.

able invention involved in the high vacuum tube had been made by Coolidge, and this invention was claimed broadly for Coolidge.

Between five and six months later, that is, on October 15, 1913, the General Electric Company filed an amendment in the Coolidge application with additional claims numbered 32, 33 and 34, specially emphasizing the broadest aspect of the invention as belonging to Coolidge.[4] Then, one day later, that is, on October 16, 1913, the General Electric Company filed a patent application in the name of its employee Langmuir. This is the application on which the present patent in suit issued. Consistently with the earlier Coolidge application and consistently with the amendment therein filed the day before, this Langmuir application explicitly acknowledged Coolidge's priority,[5] as Respondent admitted in its main brief in the court below (p. 241).

Also, consistently with the situation as it had been developed to that time, the Langmuir application made no claim to the high vacuum tube as an invention, but claimed only a specific process of effecting the evacuation of such a tube.

Again, on March 30, 1915 Respondent presented the broadest kind of a claim in the Coolidge case.[6] It is clear that when the Coolidge application was filed in May, 1913 and when the Langmuir application was filed in the following October, and as late as March 30, 1915, the position taken by the General Electric Company was that Coolidge was the inventor of the high vacuum tube. Whatever

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[4] Rec., Vol. 6, pp. 969, 970.
[5] Rec., Vol. 6, p. 664.
[6] Claim 33, Rec., Vol. 6, p. 1007.

wavering attitude the General Electric Company may have shown in the meantime, *it claimed the invention of the high vacuum pure electron discharge tube in the Coolidge patent as it issued on October 31, 1916.* Among the claims of that patent, we direct attention particularly to claims 1, 16 and 32. Claim 1 is as follows:

> "In a device for the production of X-rays, the combination of a tube provided with electrodes, the vacuum in the tube being so attenuated as practically to eliminate the production of positive ions, and means for generating electrons at the cathode or negative electrode substantially independently of the voltage impressed upon said electrodes".[1]

The only pretense of a distinction that this claim makes from the alleged invention of the Langmuir patent in suit is that this claim is limited "for the production of X-rays". Similarly for claims 16 and 32 of the Coolidge patent. In other words, the invention of the Langmuir patent was claimed for Coolidge within a certain domain, "for the production of X-rays". But it is not permissible to apportion a patentable monopoly *on a single invention* in separate patents according to different uses. The invention of the high vacuum electron discharge tube, if it be an invention, is a single invention, and the entire protection to which it is entitled must be had in one and only one patent. If, arbitrarily, the patentee chooses to restrict his claim to the field of X-ray uses, he may do so, but having received a patent on the invention of the high vacuum electron discharge tube, that patentee cannot secure another valid patent on the same invention. That is precisely what the

[1] Rec., Vol. 6, p. 1026.

General Electric Company is attempting to do by its Langmuir patent here in suit.

The last paragraph of the Coolidge patent before the claims, a paragraph that went in by attorney's amendment the last thing before allowance of the patent says:*

> "Certain broad aspects of the apparatus and methods herein disclosed are not of my invention but are the invention of Irving Langmuir and are defined by the claims of his allowed application [on which patent 1,558,436 was issued]."

Speaking strictly and properly, inventions are neither broad nor narrow; breadth and narrowness are attributes of claims of patent, not of inventions. The Coolidge X-ray tube as claimed in claims 1, 16 and 32 is one invention and the "broad aspect" is not another invention. Once having secured the grant of the Coolidge patent on a certain invention, whether or not there claimed as broadly as possible, the patentee, the General Electric Company, cannot thereafter have the Langmuir patent as a valid patent claiming that same invention, even though its claims be of different scope.

When the General Electric Company decided to change its position and claim the high vacuum electron discharge device for Langmuir, it failed to restrict all the claims of the Coolidge patent to *inventions* essentially distinguishable from what it later claimed for Langmuir. To illustrate the kind of restriction necessary, it may be noticed that the X-ray tube required a focusing shield, and it may be that Coolidge's provision of this element was an invention quite distinguishable from the invention of the high vacuum elec-

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* Rec., Vol. 6, p. 1016.

tron discharge tube. Many of the claims of the Coolidge patent refer to this focusing shield as, for example, claim 4.[9] If the Coolidge patent had been restricted to such claims, the case would have appeared much better for the General Electric Company in its effort to secure a broad patent for Langmuir instead of Coolidge. But by retaining claim 1 (quoted above) and claims 16 and 32 of the Coolidge patent, it claims the invention of the high vacuum electron discharge tube for Coolidge, and it cannot thereafter secure a valid patent on that same invention for Langmuir.

The Langmuir patent is therefore invalid for *double patenting.*

Miller v. *Eagle Manufacturing Co.*, 151 U. S. 186;
In re Dunbar, 278 Fed. 334;
Thompson Spot Welder Co. v. *Ford Motor Car Co.*, 268 Fed. 836;
Otis Elevator Co. v. *Portland Co.*, 127 Fed. 557;
Palmer Pneumatic Tire Co. v. *Lozier*, 90 Fed. 772;
Caldwell v. *Firestone Tire and Rubber Co.*, 13 Fed. (2) 433;
American Bell Telephone Co. v. *National Manufacturing Co.*, 109 Fed. 976;
Industrial Manufacturing Co. v. *Willcox and Gibbs*, 112 Fed. 535;
Dey Time Register Co. v. *Syracuse Time Recorder Co.*, 152 Fed. 440;
Pittsburgh Plate Glass Co. v. *American Window Glass Co.*, 276 Fed. 187 (affirmed 276 Fed. 849).

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[9] Rec., Vol. 6, p. 1026.

In *Miller* v. *Eagle Manufacturing Co., supra,* this Court laid down the broad principles relating to the question of double patenting, in the following language:

> "The result of the foregoing and other authorities is that no patent can issue for an invention actually covered by a former patent, *especially to the same patentee,* although the terms of the claims may differ; that the second patent, although containing a broader claim, more generical in its character than the specific claims contained in the prior patent, is also void; but that where the second patent covers matter described in the prior patent, essentially distinct and separable from the invention covered thereby, and claims made thereunder, its validity may be sustained.
>
> "In the last class of cases it must distinctly appear that the invention covered by the later patent was a separate invention, distinctly different and independent from that covered by the first patent; in other words, it must be something substantially different from that comprehended in the first patent. It must consist in something more than a mere distinction of the breadth and scope of the claims of each patent. If the case comes within the first or second of the above classes, the second patent is absolutely void".

The remaining cases above noted are all pertinent to the applicability of the doctrine of double patenting to the facts in the present case. Thus, in *In re Dunbar, supra,* the Court of Appeals for the District of Columbia held that "the same patentee" embraces a common assignee of two applicants.

The reasons for the doctrine of double patenting applied to a common assignee or patentee, as set forth in

Miller v. *Eagle, supra,* and developed more at length in *In re Dunbar, supra,* are matters of pure logic. Let us consider the specific case raised by the Coolidge and Langmuir patents. The Coolidge patent issued in 1916. Under that patent the General Electric Company secured a 17-year monopoly of the hot cathode pure electron discharge tube when used as an X-ray tube, an exceedingly important invention, according to Respondent's contention. In 1925, after it had enjoyed this monopoly for 9 years, the General Electric Company secured the grant of the Langmuir patent here in suit. This purports to give it a 17-year monopoly of the hot cathode pure electron discharge tube when used in any useful way, including its use for an X-ray tube. This is not a different invention. It is the same invention. The only difference is that in the later patent the exclusive right is stretched over a wider field of use that includes the field of the earlier patent, namely, the X-ray field. 17 years added to 9 years make 26 years, the entire term for which the General Electric Company seeks to monopolize the single invention of the hot cathode pure electron discharge tube. Its exclusive right to this invention should come to an end with the expiration of its first patent, the Coolidge patent of 1916, and the Langmuir patent should be adjudged invalid as an attempt at double patenting.

CONCLUSION.

It is respectfully submitted that the judgment of the Court below, based on the present majority opinion thereof, should be reversed and the decree of the Trial Court sustained.

Respectfully submitted,

THOMAS G. HAIGHT,
SAMUEL E. DARBY, JR.,
Counsel for Petitioner.

Of Counsel, as to "Point III" and the related part of "Point V" only (see the footnote on page 56),

CARL A. RICHMOND,
WILLIAM R. BALLARD.